MACHINERY.

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ALIGNMENT OF ENGINE LATHES.

S. ASHTON HAND.

ON this subject much has been written, but by far the greater part has been a sort of instruction to the machinist as to how to overcome difficulties caused by faulty workmanship in the building of the lathe.

The object of this article is to show how lathes should be aligned in the process of building and also to enable owners of lathes to test them properly for accuracy. It will be readily understood that in tool building all the machine work must be of the best possible character, but in the accurate fitting up of the various parts, resort must be had to scraping by hand. How much or how little of this is required depends upon the accuracy of the work done. In scraping the head and tail stocks to their bearings on the V's, care must be taken to keep them both at the same height and in a line with each other.

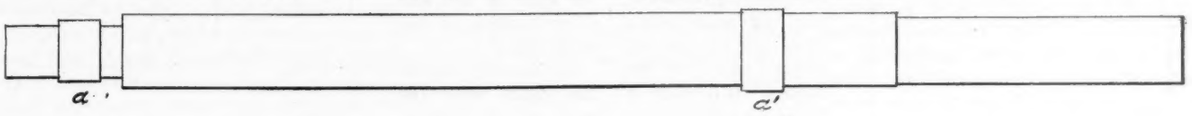


FIG. 1.

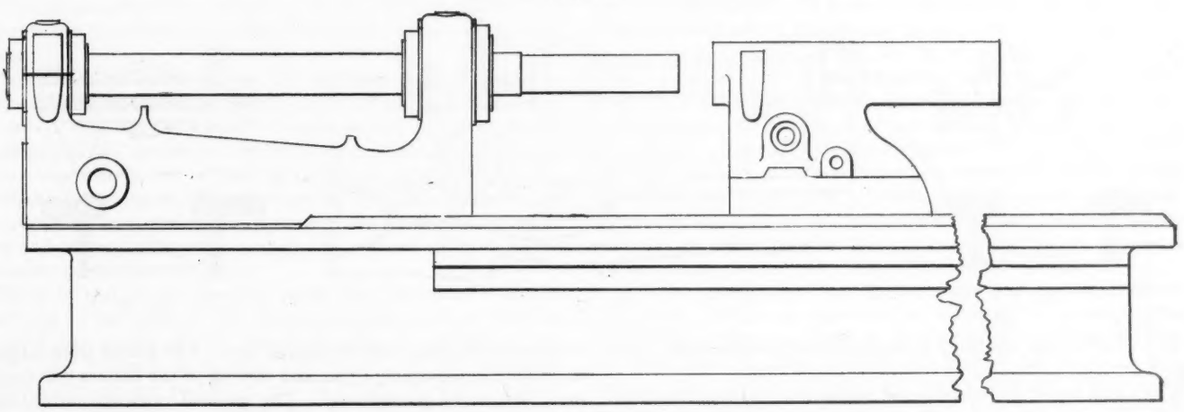


FIG. 2.

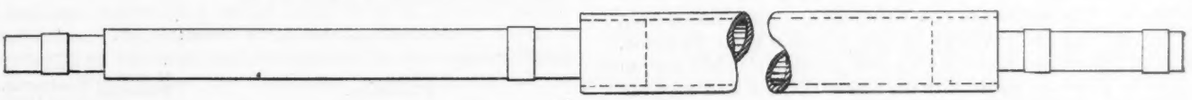


FIG. 3.

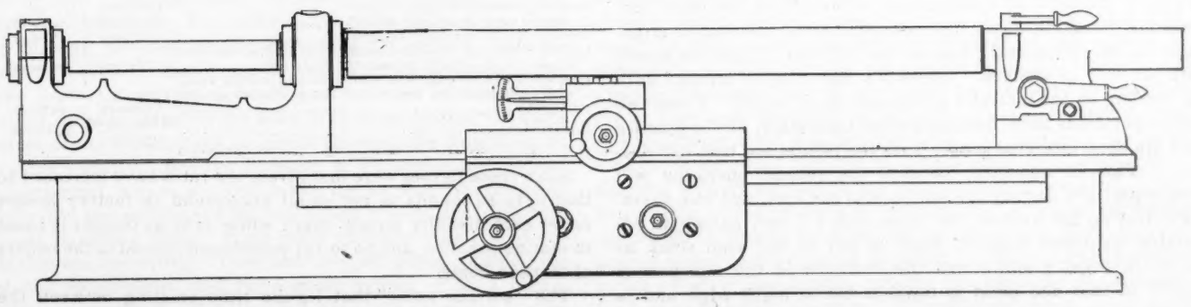


FIG. 4.

The spindle boxes should be fitted to the head stock and a proof bar, like Fig. 1, put in as shown at Fig. 2 The out board end of the bar should be a nice fit in the spindle pocket of the tail stock. This proof bar should be hardened and ground, and at about the center of the bearings in the spindle boxes the metal should be cut away, leaving only short bearings, as shown at *a* and *a'*, Fig. 1. This is done to prevent the bar from springing when the boxes are clamped tightly upon it. As the scraping progresses, the tail stock should be slid on to the proof bar from time to time; any serious difficulty in doing this will prove that either the height or alignment or both, are badly out. If a little lead be put on the out board end of the proof bar and the tail-stock slid on and off a few times, the marking will readily show in which direction the stocks are out of truth and they can be scraped accordingly.

When they have been scraped so that the out board end of the proof bar will enter to the full depth of the spindle pocket in the tail stock easily, and will do this when the head and tail stocks are at any part of the shears, then they may be said to be approximately in line with each other.

Next, separate hardened and ground proof bars are put into the head and tail stocks. These have on their ends swinging micrometers, as shown in Fig. 5. If these swinging micrometers are revolved around the proof bars and readings taken at—say each quarter of a revolution, we can see just how much our head and tail stocks are out of line with each other, and they can

be scraped until the readings are the same at all points of a revolution.

When this test can be successfully performed then the head and tail stocks will be in line with each other and consequently so will be their respective spindles, if properly fitted.

In scraping the saddle and cross-slide to a bearing, care must be taken that the former shall slide in a line parallel to the line of centers both in a horizontal and in a vertical plane, and the latter should slide in a line at right angles to the line of centers in a horizontal plane.

To test this operation of scraping a proof bar is used, long enough to go in the spindle boxes of the headstock and spindle pocket of the tail stock when they are at the extreme ends of the shears. It is made in three pieces, the center part being hollow so as to reduce the tendency to deflection to the minimum. See Fig. 3.

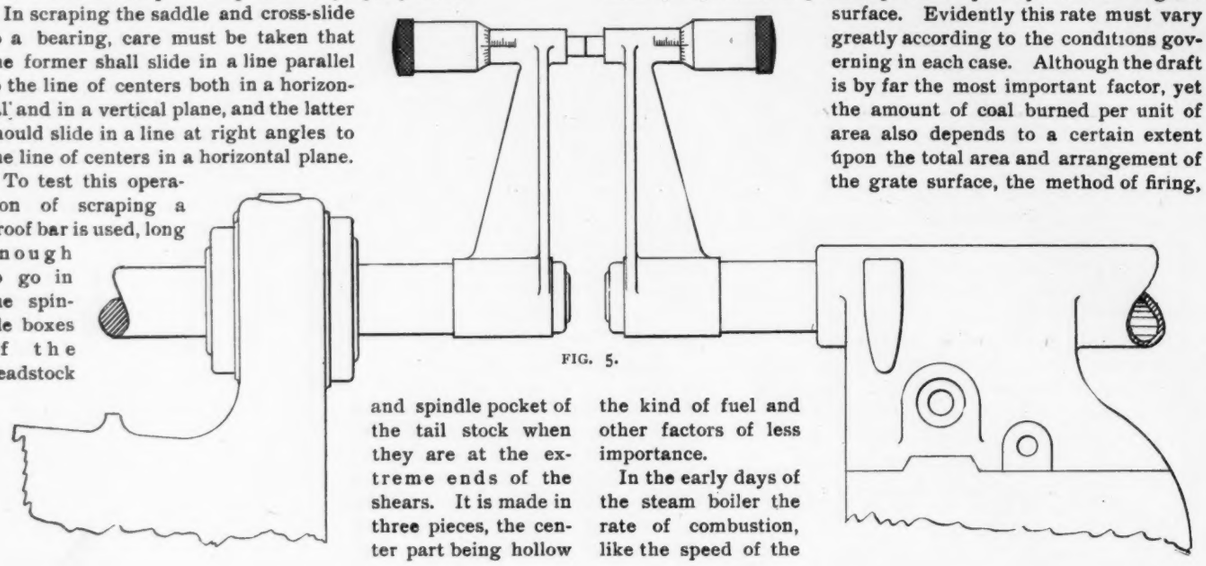


FIG. 5.

When this bar is in position and the saddle and tool block are on the shears, as shown in Fig. 4, an indicator having a contact point bearing on the under side of the proof bar is put in the tool block. The saddle can now be moved along the shears from end to end and the readings on the indicator scale be noted, which will show how much the V's that guide the saddle are out of line in a vertical plane with the line of centers and they can be scraped until the reading of the indicator is constant at all points. Another indicator is now put in the tool post, as shown in Fig. 6, the point of which bears on the side of the proof bar. Running the saddle along the shears will show the relative alignment in the horizontal plane of the V's that guide the saddle with the line of centers. These V's can now be scraped until the reading of the indicator is constant at all points. These two latter operations have been described separately, but in practice they are done interchangeably until the results are both satisfactory. This is necessary because the second operation will always partially destroy the accuracy of the first, and vice versa.

For testing the truth of the cross slide a T-bar, having an adjustable hardened straight edge, is put in the head stock as shown in Figs. 7 and 8, and the indicator in the tool post is turned so that the point is towards the straight edge and is brought in contact with it by moving the saddle towards the head stock. By running the tool block across the saddle, and taking readings from the indicator at various points, we see how near the cross slide is at right angles to the line of centers and can scrape the cross slide until the reading is constant. Upon the accuracy of this operation depends the ability of the lathe to face off squarely, a point in which a great many lathes fail.

When all the above operations have been gone through and proven, the lathe is far from being in "perfect" alignment, but as far as practical use is concerned, it is plenty good enough and very much better than 95 per cent of the lathes in the market.

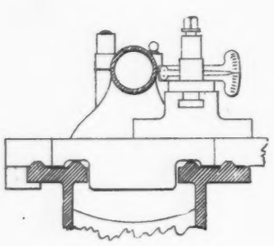


FIG. 6.

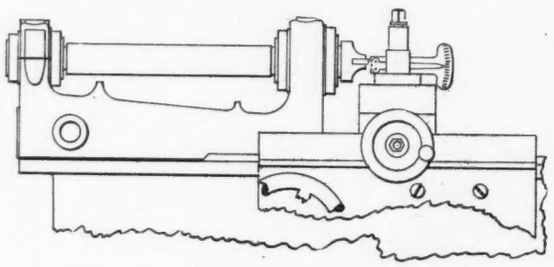


FIG. 7.

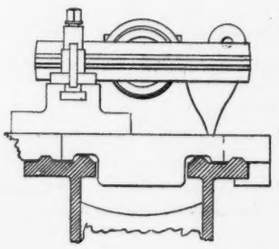


FIG. 8.

MECHANICAL DRAFT.—3.

WALTER B. SNOW.

The rate at which fuel is consumed in steam-boiler practice is usually expressed in pounds per hour per square foot of grate surface. Evidently this rate must vary greatly according to the conditions governing in each case. Although the draft is by far the most important factor, yet the amount of coal burned per unit of area also depends to a certain extent upon the total area and arrangement of the grate surface, the method of firing, the kind of fuel and other factors of less importance.

In the early days of the steam boiler the rate of combustion, like the speed of the first steam engines, was extremely low. The grates were large, the draft comparatively light, and forcing of the boilers less common than at the present day. The general rates of combustion as given by Rankine for various types of boiler and conditions of draft, are presented in Table No. 10.

TABLE NO. 10.—RATES OF COMBUSTION.

CONDITIONS.	Method of Producing Draft.	Pounds of Coal per sq. ft. of Grate per Hour.
Lowest rate of combustion in Cornish boilers	Chimney	4
Ordinary rates in Cornish boilers	Chimney	10
Ordinary rates in factory boilers	Chimney	12 to 16
Ordinary rates in marine boilers	Chimney	16 to 24
Ordinary rates of complete combustion of dry coal, the supply of air coming through the grate only	Chimney	20 to 23
Quickest rates of complete combustion of caking coal, with air-holes above the fuel to the extent of $\frac{1}{10}$ area of grate	Chimney	24 to 27
Locomotives	Blast pipe or fan.	40 to 120

Since these figures were first given, the rates have increased so that 15 to 20 pounds is not at all uncommon in factory boilers under exceptionally strong draft, while 25 to 40 pounds is usual in marine practice, and 60 to 125 pounds are burned in the boilers of torpedo boats.

The "surface ratio," that is, the ratio existing between the areas of grate and of heating surface in various types of boilers, evidently has a marked influence upon their efficiency. As the economy of a boiler is usually expressed in the number of pounds of water evaporated per pound of coal, it is evident that the surface ratio and the rate of combustion being known, the relative capacity of the boiler can be determined or measured in pounds of water evaporated per square foot of heating surface. In fact, this should be the ultimate basis of comparison.

It is evident that with a given boiler it is a comparatively simple matter to so change the setting as to permit of the use of grates of a different area, thus altering the surface ratio; and further, that a reduction of grate surface with the maintenance

of the same rate of combustion, is relatively equivalent to an increase of heating surface without change of the original grate. A reduction of grate area, without corresponding increase in the rate of combustion, such that the total amount of fuel consumed remains the same, must of necessity reduce the rate of evaporation per square foot of heating surface and consequently the capacity of the boiler.

It may be theoretically shown that with a *constant* surface ratio the evaporative efficiency of the boiler decreases as the rate of combustion is increased. But an increase of the rate, while the surface ratio remains the same, is in effect an increase in the total quantity of coal consumed. The more coal consumed, the more air required; hence the apparently logical deduction that the efficiency will be reduced. But in practice certain factors affect these theoretical considerations so that, as evidenced by statements which follow, the rate of combustion upon a given grate may be greatly increased without adverse economic effect.

It is to be noted that when the surface ratio is constant, the combustion rate becomes practically a direct measure of the total amount of fuel consumed. If, however, the ratio be changed as, for instance, by reducing the grate area, the total consumption can only be maintained by increasing the rate of combustion per square foot. Under this condition it is certainly evident that at least no greater amount of air will be required per pound of coal. In fact, experience shows that ordinarily the amount of air required will be actually reduced. Upon this fact rests one of the important advantages of mechanical draft, for by its means may be produced the intensity of draft requisite to high combustion rates.

The conditions under which this increased efficiency can be secured must, however, be clearly understood. An increase in the rate of combustion, when it is accompanied by a greater coal consumption, as would be the case when the surface ratio remains constant, is not ordinarily conducive to economy. But, when the total amount of coal consumed remains the same, and the increased combustion rate is secured by a reduction of grate area and corresponding increase in the surface ratio, a higher efficiency is the natural result.

The principal, if not the sole cause for this increase in efficiency, is to be found in the decreased supply of air which is required per pound of coal where the rate of combustion per square foot of grate is raised. The reason of this decreased requirement appears evident in the fact that the higher rate of combustion necessitates a deeper fire, and that the air supplied is therefore compelled to come in contact with a greater amount of fuel, and is afforded a better opportunity to promote perfect combustion. The intensity of the fire is increased, its temperature is higher, and more heat is radiated to the exposed boiler surfaces. Furthermore, the diminished superficial area of the grate and of the exposed interstices between the fuel, necessitates a higher velocity to secure the admission of a greater volume of air. This increased velocity in turn requires greater draft or air pressure. The volume at a given temperature passing through the coal is proportional to the velocity, but the pressure varies as the square of the velocity. Therefore, if a given grate be reduced one-half and the rate of combustion doubled, so as to maintain the same total consumption, the same volume of air would have to travel through the interstices at twice the velocity. But the pressure or vacuum would be four times as great, and as a consequence the air would be forced or drawn into spaces between the fuel which it could not reach with a lesser impelling force. Much more intimate contact and distribution are the results. Less free oxygen passes through the fuel bed unconsumed, and for a given supply of air a higher efficiency is attained. But the high pressures necessary to such results seldom exist or are attainable when an ordinary chimney is depended on for the production of draft. In fact, the present rates of combustion common in factory practice are such, largely because of the inability of a chimney of moderate height and cost to economically provide draft of sufficient intensity for higher rates. For this reason forced or mechanical draft has always been considered in a sense separate and apart from chimney draft, and until recently has been regarded principally in the capacity of producing draft pressures beyond the limits of the ordinary chimney. Consequently, the effects of increased draft and higher combustion rates have been attributed directly to the use of mechanical means, and in fact experience has shown that these effects can be economically attained only by the employment of such means.

Rankine wrote nearly forty yeas ago that "in furnaces where the draft is produced by means of a blast pipe like those of locomotive engines, or by means of a fan, the quantity of air required for dilution, although it has not yet been exactly ascertained, is certainly much less than that which is required in furnaces with chimney drafts; and there is reason to believe that on an average it may be estimated at about *one-half* of the air required for combustion." Careful tests of various types of boilers show, as recorded by D. K. Clark, the surplus air to have been as indicated in Table No. 11.

TABLE NO. 11.—SURPLUS AIR WITH DIFFERENT RATES OF COMBUSTION.

Kind of Boilers.	Coal consumed per sq. foot of grate per hour, pounds.	Surplus Air, per cent.
Cornish	2 to 4	100
Delabeche and Playfair	10 to 16	25 to 50
Longridge	20 and upwards	9¾

Mr. J. M. Whitham has recently shown in tests of a Wilkinson stoker the remarkable result of practically perfect combustion and good economy, with a combustion rate of 45.4 pounds per square foot of grate per hour when there was an actual deficiency of 11.2 per cent. in the amount of air chemically required.

A comparison of 30 tests of Babcock & Wilcox boilers has shown that practically as good results were obtained at an evaporation rate of over 5 pounds per square foot of heating surface as at 1.75 pounds, while Mr. W. H. Bryan has demonstrated that in a battery of boilers forced to nearly double their rated capacity, there was a decrease of only 6 per cent. in their efficiency, and this with a range of combustion rate between 18.074 pounds and 43 68 pounds. Numerous authorities might be quoted, but their statements are sufficient to show that under proper conditions the capacity of a boiler may be greatly increased without impairing its efficiency, and that improved economic results may, under proper conditions, be secured by considerably increasing the surface ratio and the combustion rate.

In boiler practice the force of the draft must be expended in two ways. First, a portion of it is necessary to overcome the resistances of the grate and the fuel upon it, of the combustion chamber, flues or tubes, and uptake, and of the means of connection to the source of draft, be it fan or chimney. Within the chimney or fan other resistances must be overcome. Second, the draft must in addition be sufficient to impart the necessary velocity to the requisite amount of air for the direct purposes of combustion. The velocity thus produced varies directly as the square root of the intensity of the draft and consequently the volume at constant temperature likewise varies in the same ratio. The force expended in overcoming the resistances is directly proportional to the pressure—that is to the square of the velocity—while the work done in moving the air, being the resultant of a given pressure exerted through a given distance which is measured by the velocity, becomes proportional to the product of these factors, namely, to the cube of the velocity. Therefore, if under stated conditions the resistance be increased by a thicker fire or finer coal, the intensity of draft required for overcoming this resistance must also be increased. If, however, the prior conditions were such that the maximum intensity of draft attainable was already devoted to the requirements of combustion, any demand for increased draft to overcome the increased resistance could only be met by reducing the amount of that portion previously devoted to the creation of velocity. But a slight reduction in the velocity considerably reduces the expenditure necessary for overcoming the resistance. The ultimate result, however, is that the expenditure for overcoming resistance is increased while the velocity and consequent volume of air are decreased. Both of these changes are proportionately less than would at first appear. The reason is evident in the fact that, whereas the resistances which are overcome are directly proportional to the pressure or draft exerted, the velocity is decreased only in proportion to the square root of the draft which is thus diverted from its former service of producing velocity to that of overcoming the added resistance.

In all boiler practice the most important of the resistances are those of the tubes and of the grate with the fuel upon it, while the expenditure for the production of velocity is comparatively

small. Prof. H. B. Gale found in the case of a stationary boiler furnace of ordinary construction, the following pressures in pounds per square foot:

Required to overcome entrance velocity (3.6 ft. per sec.)	0.013
Required to overcome resistance of fire grate	0.91
Required to overcome resistance of combustion chamber and boiler tubes	1.23
Required to overcome resistance in horizontal flue	0 6
Required to produce discharge velocity (11.2 ft per sec)	0.085
Total effective draft pressure	2 298
Back pressure due to friction of stack	0.19
Total static pressure produced by chimney	2.488

This total static pressure, which is given in pounds per square foot, is equivalent to 0.28 ounces per square inch, or 0.48 inches of water.

Although the ultimate object of any means of draft production must necessarily be to create draft or velocity sufficient to provide the required amount of air and to carry off the gases, yet this portion of its work is, as shown by Prof. Gale's results, almost infinitesimal as compared with the demand made for sufficient pressure to overcome the resistance of the fuel and the boiler. In other words, the ability to create sufficient pressure difference is the primary requisite to burning a given quantity of fuel, rather than the ability to move a certain amount of air. Draft-producing apparatus is not, therefore, to be based merely upon the total number of cubic feet to be moved per hour, as determined by multiplying the coal consumption by the allowance of air per pound of coal. If this were the case, a low chimney or a large slow-running fan would meet the requirements. In reality the relatively immense resistance of fuel and boiler demand that the chimney or fan shall be first designed to create sufficient intensity of draft to overcome these resistances and to create the requisite velocity. The height of chimney or diameter and speed of fan necessary to create this draft having been determined, it is only necessary to make the capacity such as to accommodate the given volume of air.

It has been the usual practice in the determination of the draft in connection with a given boiler to ascertain only the total draft as shown by the application of a gauge to the uptake, chimney or fan. From such readings it is manifestly unfair to draw conclusions as to the amount or intensity of draft to secure a given rate of combustion. For the comparison of combustion rates the draft which should be determined is that relating solely to the supply of air to, and the overcoming of, the resistances in the fire. This draft is obviously the difference between the over and under-grate pressures

Although it has already been shown that the efficiency of combustion increases and the required air supply decreases as the combustion rate rises, for the sake of simplicity in the matter of comparison, the required air supply per pound of coal may here be taken as constant for all rates of combustion. The volume of air (for equal temperatures) then becomes an index of its velocity and varies as the square root of the effective pressure or draft. Conversely, the required draft will vary as the square of the rate of combustion. Of course for the purpose of properly proportioning draft-producing apparatus, the resistances of all parts of the boiler, including the fuel upon the grate, should be carefully ascertained for all ordinary kinds of coal, types of boiler and conditions of draft.

The difficulties in the way of obtaining such knowledge are evident. As indicative of the variation in draft required for different kinds of coal, rates and stages of combustion, the results in Table No. 12 are presented.

TABLE NO. 12.—DRAFT CONDITIONS WITH COXE STOKER.

Items.	Size of Coal.		
	Buck-wheat.	Buck-wheat.	Rice.
Pressure in igniting compartment, ins. of water	0.14	0.25	0.44
" " " burning " " "	0,31	0.56	0-89
" " " " down " " "	0.24	0.49	0.73
" " " " out " " "	0.17	0.42	0.67
Pressure of blast of air " " "	0.24	0.43	0.68
Vacuum in furnace " " "	0.10	0.15	0 24
Total furnace draft " " "	0 34	0.58	0.92
Vacuum in stack flue " " "	0.13	0.40	0.58
Total draft " " "	0.37	0.83	1.26
Pounds of dry coal per hour per sq. ft. of grate	19.8	32.9	28.0

These are from a test of a Coxe stoker applied to Babcock & Wilcox boilers. This stoker, which is of the traveling chain grate type, with the fire upon its upper surface, is provided with four blast compartments under the fire. To each of these air is admitted in the desired proportion from a supply furnished by a blower.

The increased draft required by small sizes of coal is made evident in Table No. 13, which shows the relation of size of coal to results obtained in the case of a Wilkinson stoker.

TABLE NO. 13.—RELATIVE RATES OF COMBUSTION OF SMALL SIZES OF ANTHRACITE COAL.

Grade of Coal.	Size of Coal (round holes, punched plates.)	Relative Rates of Combustion for same Draft.
Pea	Through 7/8 inch and over 3/4 inch.	100
Buckwheat	Through 3/4 inch and over 3/8 inch.	85
Rice	Through 3/8 inch and over 3/16 inch.	70

Although as shown by repeated experience there often seems to be no constant relation between the total draft and the rate of combustion, yet investigation appears to show that in practice the effect of the various modifying factors is to bring the rate of combustion to substantially the theoretical basis first presented, viz.: proportional to the square root of the effective draft pressure. Thus for instance, two similar tests upon the same boiler operated by induced mechanical draft, at the works of the B. F. Sturtevant Co., Jamaica Plain, Mass., gave the results presented in Table No. 14.

TABLE NO. 14.—RELATION OF DRAFT AND RATE OF COMBUSTION IN BOILER AT WORKS OF THE B. F. STURTEVANT CO.

Designation of Test.	Vacuum in Furnaces, Inches.	Vacuum in Ash Pit. Inches.	Effective Pressure to Produce Combustion. Inches.	Coal burned per hour per square foot of Grate. Pounds.
A	0.640	0.144	0.496	21.45
B	0.372	0.078	0.294	16.45

The square roots of the effective pressures in the two cases are in the ratio of 1 to 0.769, while the rates of combustion are in the ratio of 1 to 0.767.

TABLE NO. 15.—RELATION OF DRAFT AND RATE OF COMBUSTION.

Pounds of Dry Coal burned per hour per square foot of grate.	Furnace Draft.	Resistance in Inches of Water due to			Total Draft in inches of Water.			
		Pass under boiler and through tubes. No retarders.	Retarders in tubes.	Pass over top of boiler.	No retarders. No return pass.	With retarders. No return pass.	Top pass. No retarders.	With top pass and retarders.
5	0.04	0.04	0.00	0.04	0.08	0.08	0.12	0.12
8	0.11	0.05	0.02	0.04	0.16	0.18	0.20	0.22
10	0.13	0.07	0.03	0.05	0.20	0.23	0.25	0.28
12	0.17	0.07	0.04	0.05	0.24	0.28	0.29	0.33
14	0.19	0.10	0.03	0.05	0.29	0.32	0.34	0.37
15	0.20	0.11	0.03	0.05	0.31	0.34	0.36	0.39
16	0.21	0.12	0.03	0.05	0 33	0.36	0.38	0.41
18	0.23	0.13	0.06	0.05	0.36	0.42	0.42	0.48
20	0.24	0.16	0.08	0.06	0.40	0.48	0.46	0.54
22	0.26	0.18	0.12	0.06	0.44	0.56	0.50	0.62
25	0.27	0.22	0.19	0.06	0.49	0.68	0.55	0.74
28	0.29	0.24	0.27	0.07	0.53	0.80	0.60	0.87
30	0.30	0.27	0.31	0.07	0.57	0.88	0.64	0.95
34	0.32	0.31	0.38	0.08	0.63	1.01	0.71	1.09
36	0.33	0.34	0.40	0.08	0.67	1.07	0.75	1.15
40	0.36	0.38	0.46	0 08	0.74	1.20	0.82	1.28

Exhaustive tests conducted by Mr. J. M. Whitham go still further to bear out this relation. In Table No. 15 are presented the results of a series of tests of a horizontal tubular boiler, in certain of which retarders were fitted into the tubes. Cambria Co. coal (run-of-mine bituminous) was used. A fair comparison of the furnace draft, that is the portion which is devoted to furnishing the air to the fuel, shows that after the rate of combustion passes the abnormally low values it varies substantially in accordance with the effective draft.

The following table, No. 16, is given by Hutton (steam boiler construction), but must be considered as applying only under ordinary conditions and as approximate at the best.

TABLE NO. 16.—TOTAL DRAFT REQUIRED FOR EFFICIENT COMBUSTION OF DIFFERENT KINDS OF COAL.

Kind of Fuel.	Total draft in inches of water.	Kind of Fuel.	Total draft in inches of water.
Straw	0.20	Slack, very small	0.7 to 1.1
Wood	0.30	Coal dust	0.8 to 1.1
Sawdust	0.35	Semi-anthracite coal,	0.9 to 1.2
Peat, light	0.40	Mixture of breeze and slack.	1.0 to 1.3
Peat, heavy	0.50	Anthracite, round	1.2 to 1.4
Sawdust mixed with small coal	0.60	Mixture of breeze and coal dust	1.2 to 1.5
Steam coal, round	0.4 to 0.7	Anthracite slack	1.3 to 1.8
Steam coal, ordinary	0.6 to 0.9		

TAPS OF UNIFORM PITCH.

If there is any one tool for machinists' use that is notoriously inaccurate it is the ordinary commercial tap. Inquiry among several tap manufacturers brings out the instructive information that, as one maker expresses it, "taps will change in tempering and it would seem impossible to make definite calculations against this change in stock. Nevertheless, we are having the subject constantly in view and may in time avail of some methods which will obviate some of the difficulties at present attending the manufacture of taps in having them uniform in pitch." This is about where the matter stands. It seems to be a question whether taps can be made correct in pitch and still be a commercial article.

In Mr. Colvin's notes on the Garvin machine shops in the July issue allusion was made to a tap in use there, made by threading up a piece of steel for several inches, but fluting and hardening the end only—probably for a distance of an inch or so. The tap is used as a sizer and the full threads back of the fluted portion, which have not been distorted by hardening, serve to lead the cutting edges of the tap correctly, regardless of their error in pitch.

Another tap came to our notice recently in which the difficulty is overcome by making the body of machinery steel and using inserted teeth. The one which was photographed for the illustration is 1¾" in diameter, 9 threads. In making, the body was turned down slightly below the tap drill size for a distance of 14 inches. A thread was marked on the body with a fine-pointed tool in the tool post and four lines scratched lengthwise at equal distances from each other. These lines served as guides in spacing and locating the teeth. Four sets of teeth were used, one on each quarter, spaced 14 threads apart, and steady plugs were placed between the different teeth which bear at the tops of the threads in the hole being tapped. The teeth were fitted, marked and fastened by headless set screws, and provision was made for adjusting them by screws setting up against one end. They were then threaded, removed from the body, relieved and hardened. A collar at the end of the tap guides it as it enters. This tap is the invention of a Providence mechanic, a Mr. Orup, formerly an employee of the Mossberg & Granville company, which firm, we believe owns a patent on the device.

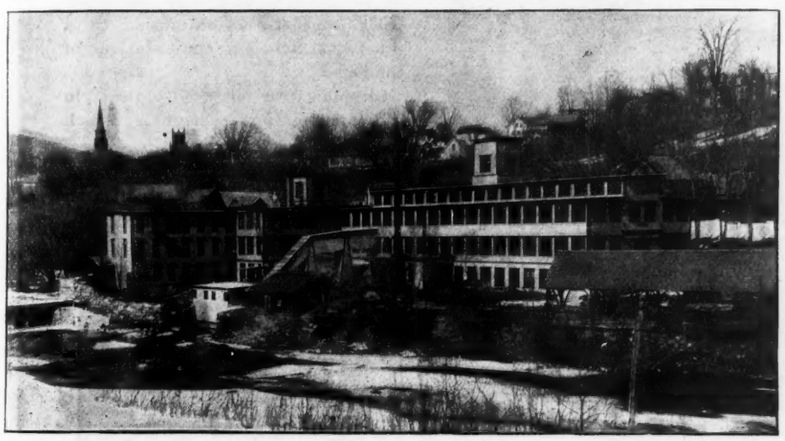


FIG. 1.—SHOPS OF THE JONES & LAMSON MACHINE CO.

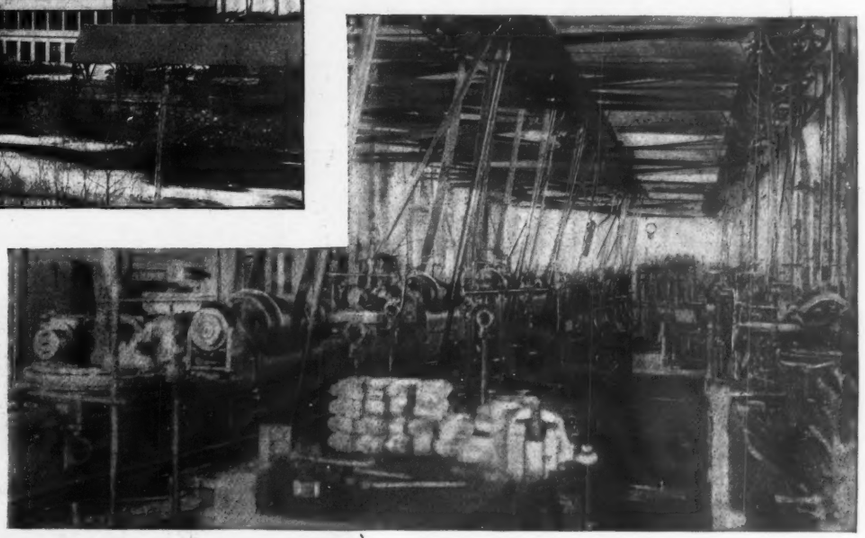


FIG. 2.—TURRET MACHINES—THEY BELIEVE IN THEIR OWN MACHINERY.

THE HOME OF THE FLAT TURRET LATHE.

NOTES FROM A SHOP IN THE GREEN MOUNTAIN STATE—A COMPANY THAT IS WORKING ON ORIGINAL LINES IN AN ORIGINAL WAY.

Until recently the town of Springfield, Vt., where the Jones & Lamson Machine Company's shops are situated, has had no railroad connection whatever. A few months ago an electric line was completed between Springfield and Charlestown, N. H., connecting with the Boston and Maine Railroad at the latter place, and now freight cars from the main line are run over this branch and for the first time Springfield receives and ships its freight by rail.

Vermont as a State is generally supposed to be closely devoted to agricultural interests. Machines and implements for farmers' use, such as are manufactured a few miles south of Springfield, appear to be a logical product of the State; but the fact that a modern shop, turning out metal working machines of the most modern kind, is situated in a small Vermont town, leads one to inquire into the causes which led to the selection of this location and to ask what results are realized.

The situation of the works is easily explained by the fact that the original company started at Windsor, Vt., and it was very natural that it should remain in that locality. It started as the Robbins & Lawrence Company sometime in the "forties." Rifles were made at one time and later a line of machine tools, which included lathes planers, milling machines and drill presses. The first turret machines made in this country were built by this firm. Fred W. Howe, who was a very original designer and served as superintendent of the company, probably originated the turret, but did not make it revolve automatically. This was accomplished by H. D. Stone, who was at one time draughtsman and later superintendent. The first turret machine was built in 1855 and was used for making gun nipples. The Jones & Lamson Company was incorporated in 1849 and moved to Springfield in 1888.

Mr. James Hartness, the general manager, stated in conversation with the writer that, owing to the good conditions and amicable relations that generally exist in the smaller places he believed that the results obtained had been fully as good as might have been realized nearer a large center. He did not consider the freight charges a serious objection, owing to the high labor cost per pound on the class of machinery made there. Contrary to my expectations, also, he did not enumerate lower wages as among the advantages of the place. The average wage rate is $1.92 per day; the best machinists receive about $2.50, as elsewhere in New England. It should be said, however, that no apprentices are employed, which would tend to raise the average rate.

Before proceeding further I wish to state, that while these works are off from the beaten line of travel, I believe that any one interested in things mechanical will feel well repaid for the time spent in visiting them. It is one of the shops turning out work along strictly original lines, both in points of design and methods of manufacture. At a later date I hope to describe some of these points for our columns, in addition to the notes given herewith.

LARGE VS. SMALL LATHES.

The 2 x 24 flat turret lathe, which takes two-inch stock and turns 24 inches long, is the only machine built by the Jones & Lamson Company, excepting a modified form of the same lathe, designed especially for cast iron work. The regular machine, however, can be fitted for either steel or cast iron work.

The feature of these shops is the large number of uses and great variety of work that is found for the flat turret lathes; and

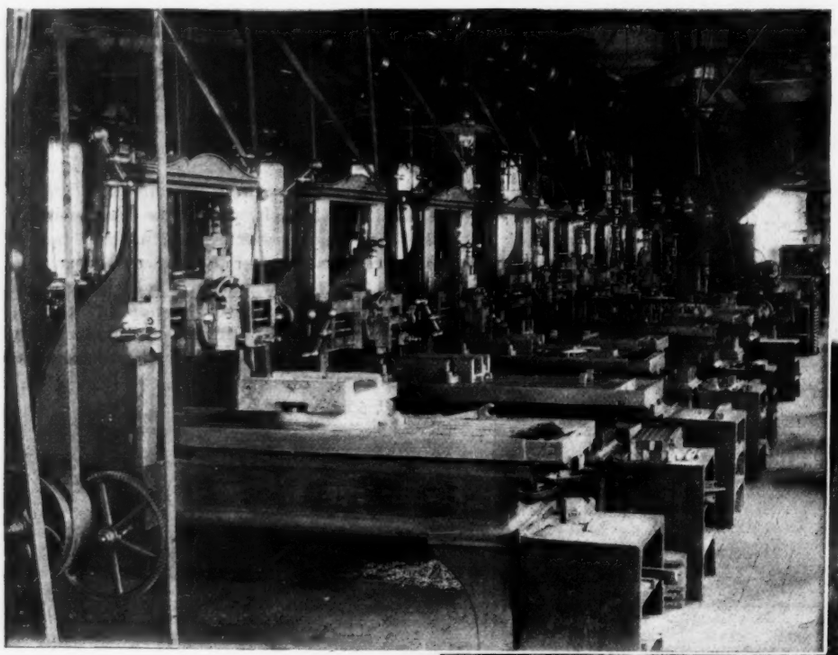


FIG. 3.—ROBBINS & LAWRENCE PLANERS.

the cost reductions that nave been effected thereby afford an excellent example of the capabilities of these machines. There are 20 turret lathes in operation, mostly of this type. Among them is a massive 3½-inch machine of the same style, with a number of original features. The experience of this company, however, has been that most of the wrought iron and steel work, which properly comes within the range of a turret machine, can be done to better advantage on the regular 2 x 24 size. Heavy bars through the spindle tend to tear things to pieces when run at a considerable speed, and one of the essential features of turret machinery—that of quick and easy operation—is sacrificed when the dimensions become large. Moreover, the amount of stock to be removed in any case increases, not directly as the diameter, but more nearly as the square of the diameter, and as work increases in size the waste therefore becomes excessive when the solid bar is used. It is thought to be better practice to resort to forging for large work, drawing the pieces out so that they can be held in the 2-inch chuck of the standard machine. They can then be operated as readily as pieces of smaller diameter and the cuts are no heavier than on smaller work.

TURRET LATHE ATTACHMENTS.

Illustrations 6 and 7 show two attachments that are now supplied with the flat turret lathe and which will be interesting to operators of these machines. The first is a central oiling arrangement for twist drills, which obviates entirely the frequent withdrawal of the drill and the slow feed necessary where there is no such arrangement. An oil tube drill is used, which is held in a bushing in the tool holder in the ordinary manner. The bushing extends back through the holder towards the center of the turret and is drilled and tapped on top for a gas pipe connection with the oil pump. Since the hole in the bushing is closed at the back end, the oil is forced out through the drill tubes. The joints in the piping are so arranged that the pipe does not interfere at all with either the cutting-off handle, or any other of the turret tools. A new design of joint is being used for the piping in which the spring clip holding the two parts together is avoided and a tight joint maintained under any reasonable pressure.

In Fig. 7 is shown a forming tool attachment in which the cutting tools are carried by swinging arms, supported from above, instead of by the usual slides. This attachment was designed primarily for forming bicycle hubs, but can be employed for any work of a similar character and does not interfere with the use of the machine for other purposes, since the arms can be swung up out of the way entirely.

The bar B, which gives rigid support to the arms, is held at one end by an upright bolted to the head stock, and at the other end by a bracket attached to the outer end of the bed.

Circular cutters are used, of the style indicated in Fig. 10, page 42, which

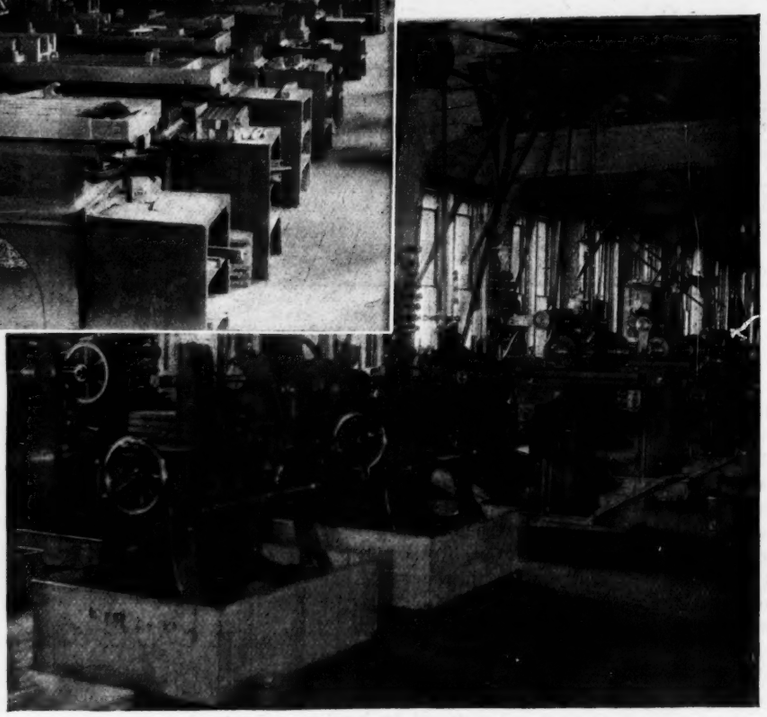


FIG. 4.—MILLING DEPARTMENT, SHOWING DRAINAGE PANS.

besides admitting of indefinite grinding, like the ordinary flat former, can be turned up in a lathe at a comparatively small cost. Moreover, by having in stock a number of disks of different diameters and shapes, formed cutters, suitable for roughing out pins and similar pieces, can be quickly assembled, by placing side by side disks of the necessary size and shape.

The method of operation will be clearly understood from the illustration. The cutters are placed on the fluted arbors A, A. These flutes serves the purpose of keyways and afford a coarse adjustment for the cutter by simply setting the latter in about the right position and pushing the key into the nearest slot. The fine adjustment can then be obtained by the set-screws and levers D, D.

The two arms are geared together at the top and are fed in toward the center by cams, one for the front and one for the

back arm, the former being visible at C. Either hand or power-feed is available, the cams being rotated by worm and worm-wheel.

The most interesting attachments in use on the flat turret lathe are the "jig-tools," with which those in charge of the machines are more or less familiar, but probably some are not so familiar as they ought to be. The tools, or jigs—they are really a combination of both, as their name implies—are simply cast iron plates to which are attached all the tools for doing a particular job. The plates are bolted to the top of the flat turret and when the tools are once set, it is intended that they shall not be disturbed again except for the purpose of grinding. When a job is finished, the plate, with its tools, is taken off and is laid on the shelf for future us.

sired head is obtained by a power pump and regulated by a safety valve and by-pass, the latter discharging into a tank in the upper part of the building, when the pressure becomes high enough to open the valve. Pure lard oil is used. Formerly this was used in small quantities, drop by drop, and as usual a considerable portion of it went to waste through ineffective means for catching the oil. When the drainage pans were put in it was thought that if the cutters were deluged with soda water the results ought to be as good as were derived when lard oil was used in small quantities. Such was not the case, however, the mills had to be ground every few hours, and lard oil was gradually added to the mixture, until finally it was decided to throw the whole compound away and start anew with pure lard oil. The mills are flooded with it, and with the system of pans there

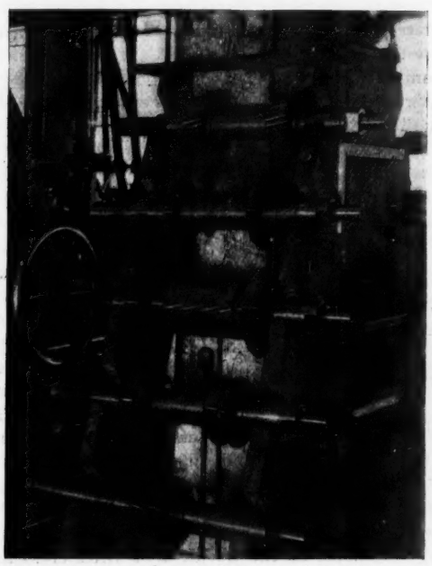


FIG 5.—CUTTERS FOR MILLING BEDS.

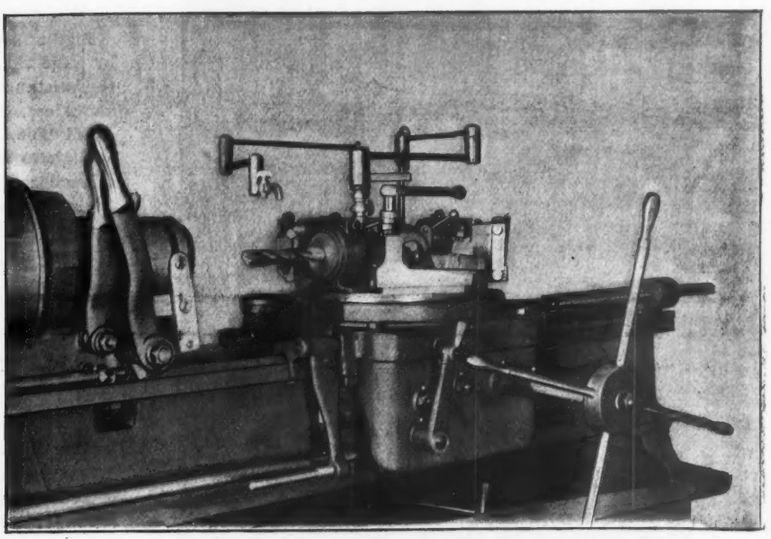


FIG. 6.—CENTRAL OILING ARRANGEMENT.

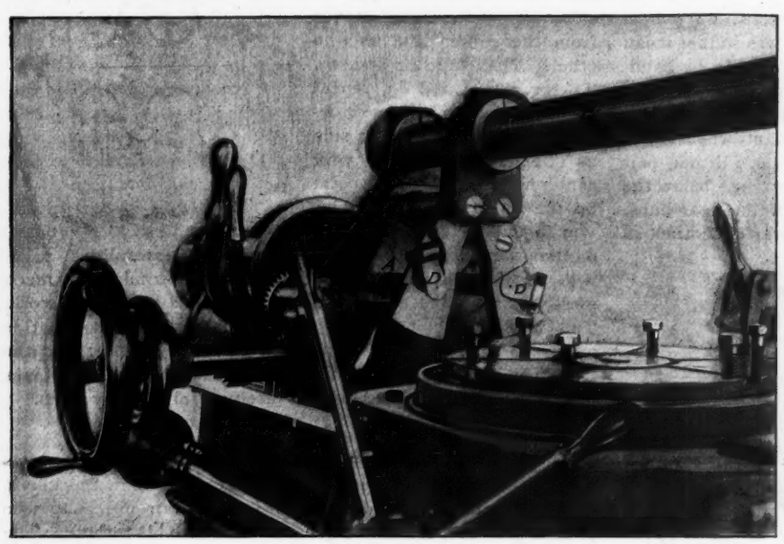


FIG. 7.—FORMING ATTACHMENT FOR TURRET LATHE.

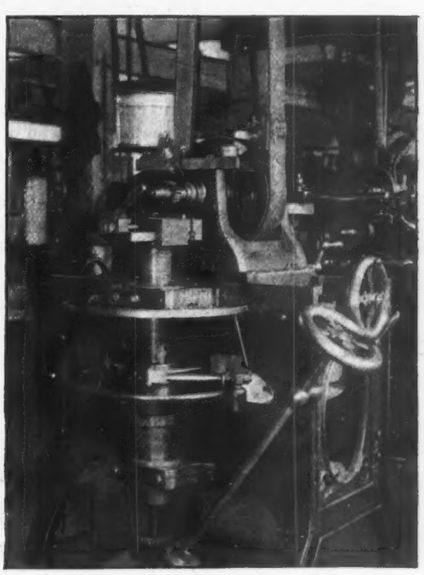


FIG. 8.—INDEX MILLING MACHINE.

These fixtures, besides reducing the time of setting up, make the arrangement of tools for finishing castings or other large pieces a comparatively easy matter.

MILLING MACHINE PRACTICE.

Fig. 4 is a view in the milling department and shows a row of milling machines fitted with drip pans, which allow the free use of oil on the milling cutters. The pans are of sheet iron and come up well around the bases of the machines. Where the tables are long and have considerable travel, sheet iron wings are extended out so as to catch the drip. Both the milling machines and screw machines are piped from a common oil supply. The de-

is very little loss.

The beds for the flat turret lathes are now being milled, both roughing and finishing, on a Beaman & Smith horizontal spindle machine. The cutters are shown in Fig. 5 on a rack beside the machine. It takes about two hours longer to mill a bed than it did to plane it, but the work comes free from tool marks and in better shape, so that there is a considerable gain in time in the scraping.

SOME "OLD ORIGINALS."

There is rather an imposing array of small planers on the first floor of the shop, of which Fig. 3 is a photograph. These

are machines that were built by Robbins & Lawrence, and seem to have stood up well under the test of years.

Another old Robbins & Lawrence machine is the drill press shown in Fig. 9. It has a screw feed instead of the more modern rack feed, but in connection with it there is a very good

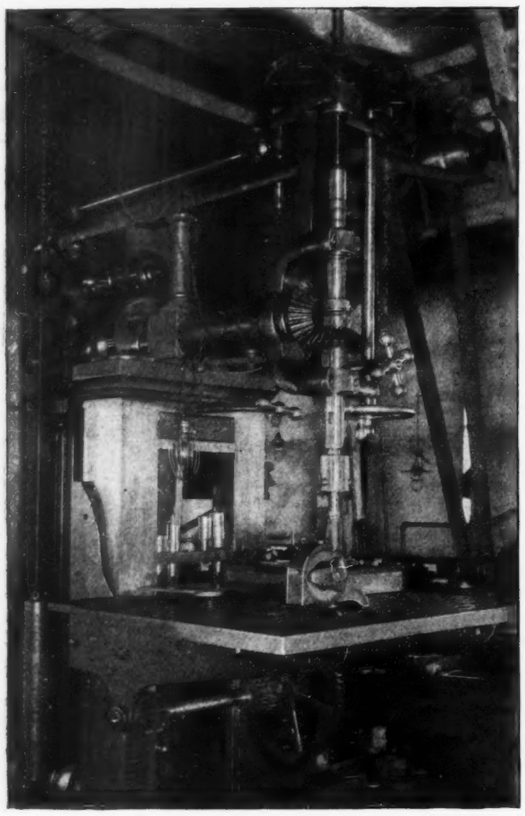


FIG. 9.—MADE IN 1849.

arrangement for the quick return. Sometimes the nut which feeds the screw and spindle down is made in halves so that it can be opened, allowing the spindle to be run up quickly by hand, when the halves of the nut can be closed in again, ready for feeding down. In this case the nut, instead of being split, is driven through two pairs of gears from the upright hand wheel shaft, one pair giving a slow and one a rapid motion. Either pair can be thrown in or out at will by a knob seen just below the hand-wheel, which operates a clutch inside of the gear hubs. The result is to give a quick, or a slow and powerful motion, as desired.

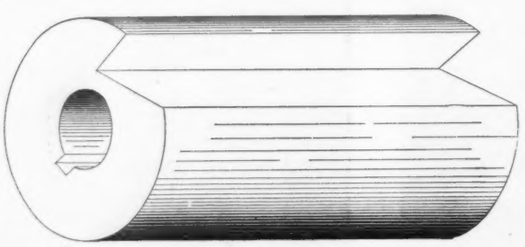


FIG. 10.—FORMED CUTTER.

Still another of the "old originals" is shown in Fig. 8. This is an index milling machine which needs but little description. The index plate is at the lower end of the column at the front of the machine, and the vise for holding the work at the top. A machine of this sort is useful for many jobs that have to be done in the shop, and it is rather strange that they are not more generally made and used. L. G. F.

* * *

THE new "Kaiser Wilhelm Der Grosse" the largest vessel afloat, and which is expected to smash the world's record, is 648 feet long, has a displacement of 20,000 tons and two triple expansion engines with cylinders of 52, 89¾ and 96½ inches diameter. There are two low pressure cylinders and the engines run at 75 revolutions at full power,

A FEW KINKS.

"CHIPS."

A handy drill for countersunk cone head screws is shown in Fig. 1. As will be seen, it drills for the body of the screw, for the tap at the point and countersinks for the head at one operation. They can be readily made if one has a lathe center grinder similar to the one shown a few months ago.

FIG. 1.

Take your round steel and forge it flat of the required width. Put the round shank in the drill chuck and put on your grinder. Grind with the emery wheel to the required size and give the required offsets and angles. Harden and temper and it is done, with very little time or trouble. I've made lots of them in that way.

Fig. 2 is a little tool or gage for measuring the distance between shoulders, through a small hole, just large enough to pass the head *a*. By cupping the head *a*, as shown, a fair bearing is secured, (*b* is also cupped, but is not shown). Thumb-screw *c* holds *b* in any desired position.

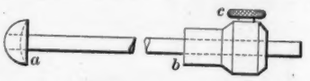


FIG. 2.

Figs. 3 and 4 show a handy method of laying out irregular curved figures. It is comparatively easy to draw one side of a turned piece, or any other piece, but to make the other side like it is a different matter. It's something like the man setting out apple trees; he had no difficulty in getting the first *two* trees in line but the *third* one was the sticker.

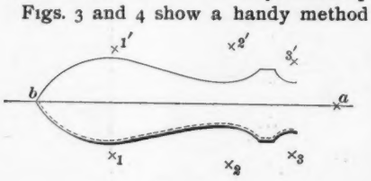


FIG. 3.

Taking Fig. 3, draw the line *a b* and sketch the handle as desired. Then find regular curves with the compasses for each curve of the figure. Mark the point of the needle by a little cross as shown. Then with the needle point on *a*, find the distance *a* 1 and work it on the opposite side at about the same distance from the center line as the other. Then take *a* 2 and *a* 3. Taking *b* 1, *b* 2 and *b* 3, repeat the performance and you obtain a cross on the other side as 1′, 2′, etc. This gives your center mark for the needle point on the other side and enables you to duplicate the first line on the other side, if you have done your work carefully.

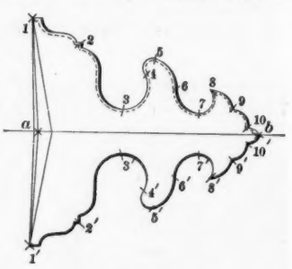


FIG. 4.

Fig. 4 is simply an extended case of this kind, with much more to it than the other, but it can be done by careful work. This case does not find the centers for dividers, though this might be done. But with such an irregular figure, some of the main points in the curve, for free-hand sketching. This is a handy thing to remember, as it is often useful in many cases.

* * *

DR. DE LAVAL, the inventor of the De Laval steam turbine, has had an engineering novelty at a recent exhibition in Stockholm in the shape of a coil boiler designed to stand from 1000 to 3000 pounds pressure, to be used in connection with his turbine. The water is pumped continually into one end of the tube, and escapes as steam at the other end, through the nozzles direct to the turbine, without having entered any steam chamber whatever, which would only be a source of danger from explosion. In case the tube should happen to burst, the steam in the broken part would rush out and as much steam would continue to do so as could pass through an opening equal to two sections of the tube (one at each end of the fracture) until the boiler had emptied its contents. This quantity of steam is not greater, however, than can pass through the flues of the boiler and escape through the chimney. As the steam and water capacity of the boiler is reduced to the smallest dimensions possible, the boiler is sensitive to every change of load. It was therefore found necessary to regulate it by a variable air blast.

MARINE ENGINE DESIGNS.—3.

PISTON AND CONNECTING RODS.

WILLIAM BURLINGHAM.

GOVERNMENT REQUIREMENTS.

These rods should be made of a steel with a high ultimate tensile strength, as the softer steels do not wear well. The government requirements are that the test pieces must show 80 000 pounds tensile strength, 50 000 pounds elastic limit, and an average elongation of 25 per cent. in two inches, no piece falling below 23 per cent. For bending, one longitudinal bar, one-half inch thick, cut from each forging, must stand bending double, when cold, to an inner diameter of one-half inch without showing cracks or flaws.

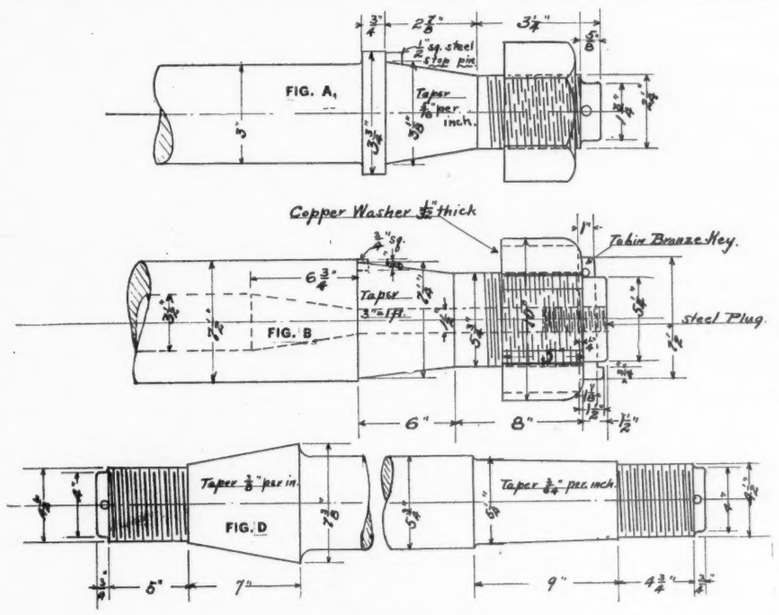
No test piece shall be cut off until the object shall have received final treatment. No test piece shall receive more reduction than the least reduction received in that half of the forging from which the test piece was taken.

For the merchant service the tensile strength is usually somewhat lower, say from 60 000 to 70 000 pounds per square inch. This is the strength of ordinary commercial steel. As the factor of safety in the government work is higher than in the merchant marine, we are enabled to use this softer steel, thus decreasing the cost; the high test steel being rather more costly and difficult to handle.

The rods are subject to alternate compression and tension, and if stiff enough for the compressive strains they will have ample tensile strength; consequently we will consider the compressive strains only in determining the diameter of the rod.

HOW TO CALCULATE THE SIZE OF PISTON RODS.

When the piston is well guided at the crosshead end, it may be considered as a strut or column fixed at both ends, but when the crosshead is of such design as to offer little resistance to bending—usually on small engines—it must be considered as a strut fixed at one end and loose at the other.



TYPES OF PISTON RODS.

Piston and connecting rods must be of such diameter as to resist the suddenly applied loads without bending. To this end the tensile strain due to the unbalanced load on the piston is usually but 2 000 pounds and 3 000 pounds per square inch in the merchant marine and naval service respectively.

A very good method of calculating the diameter of the piston rod is as follows:

Assume a diameter. Divide length of rod from under side of piston to crosshead by the least radius of gyration. The least radius of gyration of a circular section is equal to the diameter divided by four.

Let L = length of rod.
" R = least radius of gyration.

then

$$\frac{L}{R} = Q$$

Substitute Q in the following table taken from the "Handbook of the Pencoyd Iron Works," with their kind permission. This table contains the classified averages of an extensive series of experiments on the destructive pressures or the ultimate load at the point of failure. For rods fixed at both ends use column for "Fixed Ends." For rods fixed at one end use column for "Round Ends."

TABLE NO. 1.—STRUTS OF MEDIUM STEEL.

DESTRUCTIVE PRESSURES IN POUNDS PER SQUARE INCH FOR STEEL OF MEDIUM GRADE ABOUT 70 000 POUNDS PER SQUARE INCH.

$\frac{\text{Length}}{\text{least rad. of gyration.}} = Q$	Fixed Ends.	Hinged Ends.	Round Ends.
		70 000	
20	70 000	51 000	66 900
30	51 000	46 000	47 700
40	46 000	70 000	41 900
50	44 000	51 000	38 800
60	42 000	46 000	35 600
70	40 000	44 000	32 600
80	38 000	42 000	29 700
90	36 100	39 700	26 500
100	34 200	34 700	23 400
110	33 100	31 900	21 100
120	31 900	29 800	18 800
130	30 100	27 700	16 500
140	28 200	25 500	14 200
150	26 800	23 200	12 300
160	25 300	20 700	10 400
170	23 400	18 100	9 240
180	21 400	15 900	8 030
190	19 400	13 700	6 990
200	17 900	12 200	6 120
210	16 200	11 000	5 500
220	15 000	9 800	5 000
		8 800	

Divide the destructive pressure thus found by the tensile strain per square inch on the rod of assumed diameter. The quotient C thus found is the ratio between the working and destructive stress. This should be a constant and equal to one given by the average of a number of well tried and good working engines. For example, suppose we wish to figure the diameter of rod for one engine

$$\frac{24 \times 34 \times 48 \times 68}{42}$$

210 pounds steam.

Assume diameter of rod 5¾ inches, length, 80⅝ inches, least radius of gyration,

$$\frac{5.75}{4} = 1.438.$$

$$\frac{L}{R} = Q = \frac{80.625}{1.438} = 56$$

$$\frac{\text{Unbalanced load}}{\text{Area rod}} = \frac{55\,000}{25.96} = 2\,118 \text{ pounds.}$$

Fixed ends, destructive stress = 43 000 by interpolation.

$$\frac{43\,000}{2\,118} = 20.3$$

The constant for large marine engines, high piston speed, should be from 20 to 22, and for small light engines from 17 to 19. These constants are averages taken from a number of good engines now in actual service. In very small engines the diameter of the rod is determined by the size of nut and required taper, necessitating a rod with a very high constant, as much as 25 or 28 at times.

It is absolutely essential that the rod makes a perfect steam tight joint with the piston, and so secured as to preclude all liability of a draw under the sudden shocks it is bound to undergo.

The tapers used by different firms vary, but below will be found a few good examples. This taper is necessary, as it is nearly impossible to make a tight joint without it. It is ordinary practice to use a shoulder to prevent the rod wedging into the piston and thereby tending to split it. Incidentally it allows

Mr. Burlingham calls attention to the following typographical errors which occurred in his article in the August number:

Page 364, second column, "m t" should equal 4 872 000, instead of 487 200.
Page 364, second column, formula at bottom of page should read

$$D = \text{diameter} = \text{constant} \times \sqrt[3]{\frac{\text{I. H. P.}}{\text{Rev per min.}}}$$

the rods to be turned true, after long wear, without changing the taper.

Figs. A and B show methods of affixing rods to pistons in government work for small and large engines respectively; taper for crosshead ends $\frac{3}{64}$ inch per inch. Fig. D shows a very good commercial method. In the later government engines the crosshead is forged in one piece with the pistod-rod, and a bronze shoe bolted on, the material being nickel steel, oil tempered and annealed, parallel parts smoothly and accurately ground, with an axial hole drilled entirely through the rod. The diameter of the piston-rod nut is settled by the strain allowed at the root of the thread from 5 000 to 5 500 per square inch for steel, and for large engines about 4 500 per square inch. These nuts should all be secured by split pins or some other equivalent device to prevent all danger of their working loose.

CALCULATIONS FOR CONNECTING-RODS.

Figs. F, G and H show the three important types of connecting-rods. It is preferable to have the gudgeon, or crosshead pins, on the crosshead, with the bearings on the connecting-rod, as in Fig. F, rather than as in Fig. G, where the pin is fast in the rod. With this construction the rod is easier to overhaul and keeps its alignment better.

Fig. F was used in the St. Louis and St. Paul and many other good boats. It is claimed that this style is less expensive to make on large connecting-rods, and is as stiff as those forged in one piece. This claim would seem to be justified by practice, although many good engineers are apt to condemn it.

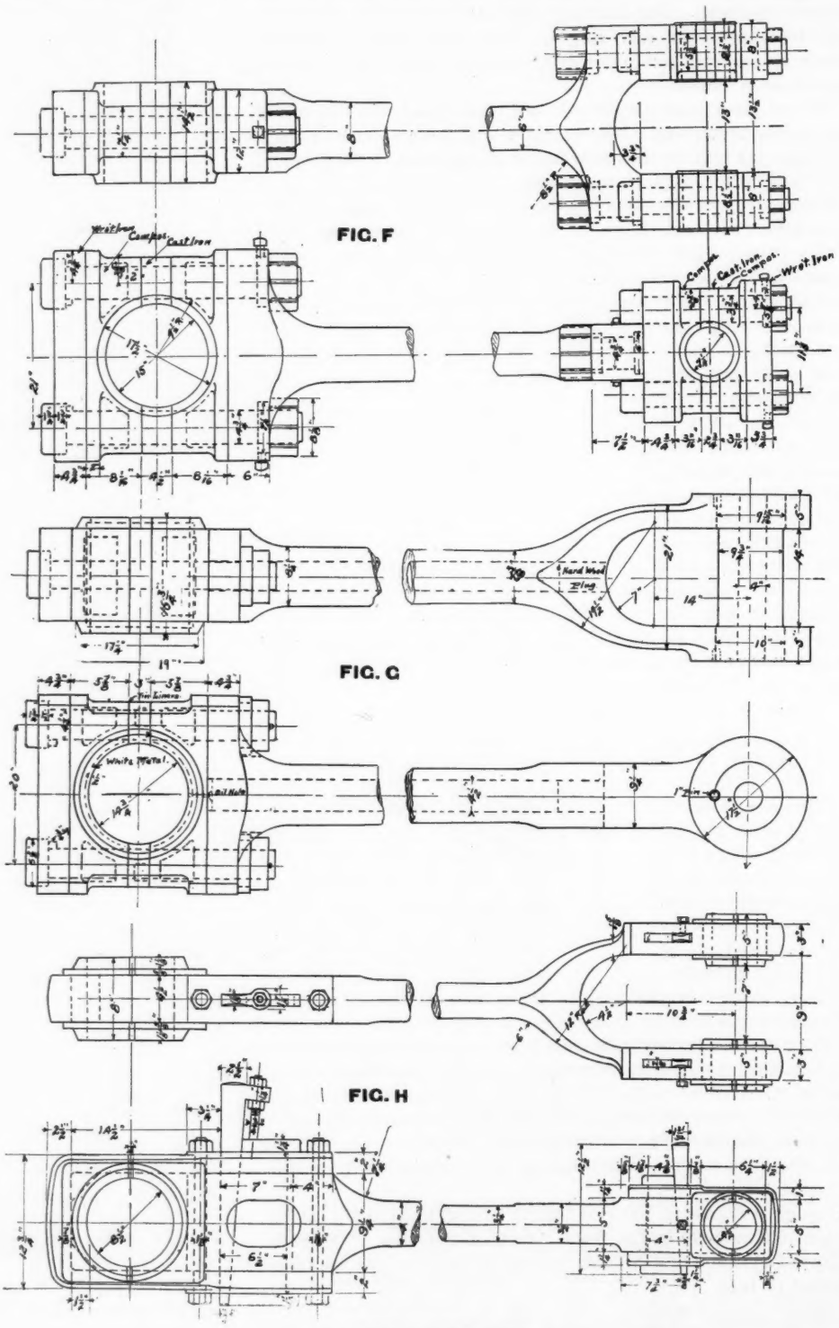
Style H is mostly used for small engines in tug-boats, etc., and is a very safe and secure type.

The diameter of connecting-rod is calculated from the same formula that is used for piston-rods, using column under "hinged ends" for destructive stress. The constant should be 18 to 19 for light engines, 19 to 21 for medium engines, and 21 to 23 for large engines with high piston speed. Take the calculated diameter as the mean diameter of the rod and the length equal to the distance from center of crosshead pin to center of crank-pin. The diameter of rod at neck should be about nine-tenths of mean diameter, and the crank-pin end about one and one-tenth of the mean diameter. The length of the rod or distance between centers should never be less than twice the stroke. Two and a quarter times the stroke is a very prevalent practice.

The diameter of the crosshead pins should be about 1.1 times the mean diameter of the connecting-rod subject to 600 or 700 pounds pressure per square inch on the bearing surface of pin. The section of metal at the end of each fork on crosshead end of rod should have about seven-tenths of the area at the neck. The thickness of the tee ends should be from 1 to 1.25 times diameter of bolts passing through them.

The diameter of the crank-pin and crosshead bolts should be such that the strain at the root of the thread shall be from 3 500 to 4 000 pounds per square inch. This may be increased to 4 500 for naval work. These bolts should be well secured from turning by small square keys under the heads. The nuts should have collars and collar set screws, as shown in Fig. F, and be further secured by split pins, as it is absolutely necessary that these bolts are well secured against any movement from vibration. Large bolts should have provision made in the top end for insertion of a tap bolt for lifting.

Round nuts slotted for a spanner wrench are often used for these bolts; they can be fitted closer to the rod and are much better looking. Wrought iron nuts should be used with steel bolts, as steel nuts have a tendency to seize or tear unless well lubricated.



TYPES OF CONNECTING RODS.

The necessary section for connecting-rod caps is determined by the formula for a beam supported at both ends, and uniformly loaded, viz.:

$$W \frac{6 f z}{l},$$

the constant being slightly modified from the regular formula by the substitution of 6 for 8, where W is the working load per inch of length, l the distance from center to center of bolts, and

s equals modulus of section, which for a rectangular section would equal

$$\frac{\text{Breadth times depth}^2}{6}$$

That is for a rectangular section cap the formula would become

$$W = \frac{f \times B \times h^2}{l}$$

In estimating breadth of caps care should be taken to deduct the diameter of all oil-holes. f should equal from 8 000 to 9 000 pounds per square inch for mild steel, if carried by one cap, and 7 500 to 8 500 if carried by two caps. The width of the cap should never be less than seven-tenths the length of the pin, and better if made from .75 to .8, as the brasses are then well supported.

The crosshead pin brasses should have no white metal, as this metal does not work well under high pressure and small angular movement. The over-all thickness of the crosshead and crank-pin brasses, including white metal, is determined by the formula

$$+ = \frac{D}{6.5} + .2 \text{ for crosshead end.}$$

$$+ = \frac{D}{6} + .2 \text{ for crank-pin end.}$$

The thickness of white metal for crank-pin brasses is equal to .034 D + .125. It is the usual practice to carefully hammer the white metal to consolidate it, although some authorities claim

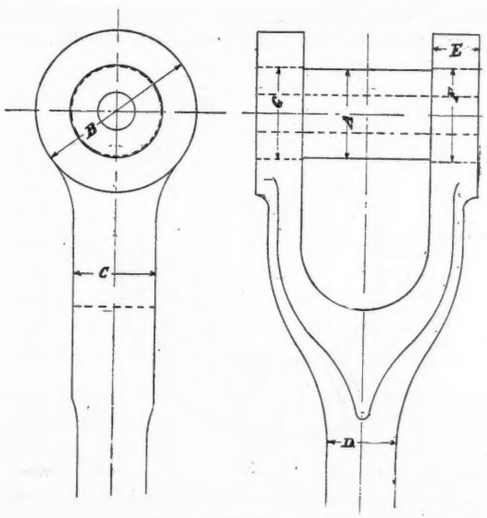


FIG. K.

that this should on no account be done, as it tends to separate the white metal from the brass. It is a very good plan to carefully tin the brass before running in the white metal. The strips in the brass for holding the white metal and delivering the oil are often badly arranged. They should be placed so as to guard against all the oil flowing out at the ends of the bearing.

Where there is an oil-hole there should be a boss cast in bearing, as the white metal chips and cracks, unless protected in this manner. The side of the bearing for crank-pin must be eased away from the pin to allow for the entrance of oil and to prevent the brasses gripping the pin when heated. The crosshead pin should be flattened slightly on each side, to allow for a good flow of oil.

The upper brass of the crank-pin usually has a centering boss into the connecting-rod. Between the upper and lower brasses should be inserted a composition liner, and in addition some thin tin liners, all secured by dowel pins. The heavy brasses, caps, etc., should all be tapped for lifting bolts, and if round heads are used for the bolts they should have a hole drilled in them for turning the bolt, so that the key or pin under the head can be brought over the keyway.

If the rod is hollow, hardwood plugs should be fitted in each end. If the crosshead pin is fixed to the connecting-rod, as per Fig. C, the rod should be shrunk on the pin and the pin otherwise secured by small screw pins at the ends. The proportions for a rod of this kind are determined as follows (see Fig. K):

$$\frac{B}{A} = 1.81, \quad \frac{E}{A} = .5, \quad \frac{C}{D} = 1.2.$$

F and G are made slightly larger than the pin, but F smaller than G. Naturally these may be varied to a slight degree to get even dimensions.

Be certain that the depth in the throat of the fork is enough to clear piston-rod nut when connecting-rod is at its greatest angle.

Clearance should be allowed between the crank webs and the crank-pin brasses from $\frac{1}{16}$ to $\frac{1}{8}$ inch on each side, depending on the size of the engine.

The sizes of rods, if figured from the preceding formulæ, will give good satisfaction, working well under all conditions, with a sufficient degree of stiffness.

I am greatly indebted to Mr. G. E. Smith for his help in getting out these figures and drawings.

* * *

HOW TO CALCULATE, DESIGN AND CONSTRUCT ELECTRICAL MACHINERY.—5.

WM. BAXTER, JR.

In Figs. 22 and 23, given in the third article, the winding of ring armatures was shown, and it will be remembered that it consists simply in winding the wire in the same direction in all the sections, connecting these to form a continuous wire from end to end, and then connecting the beginning of all the sections to the commutator segments opposite to them. The drum winding is the same in principle, but as there is no center space as in the ring, through which the wire may be passed, that portion of

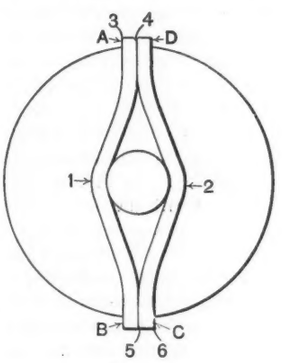


Fig. 33

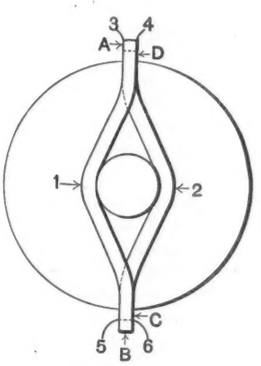
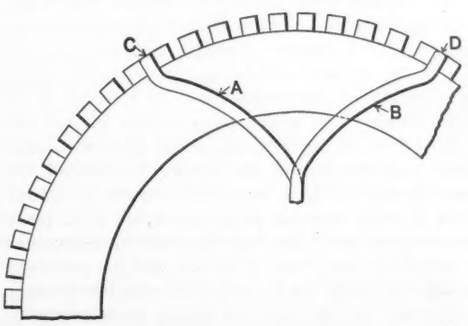


Fig. 34

each turn that, in the ring, would be located on the inside surface of the rim, is carried over to the opposite side of the drum. This is illustrated in Figs. 33 and 34. Take the coil No. 1 for example, and the side marked A from which the two ends 3 and 4 of the wire project, is the counterpart of the outside of a coil on a ring armature, and the side B from which no ends of wire project, is the counterpart of the side of a ring coil that is within the rim. The coil No. 2 has its outside diametrically opposite to that of coil 1, as shown at C, where it will be seen that the two ends 5 and 6 come out. From this it will be seen that in a drum



FIN. 35.

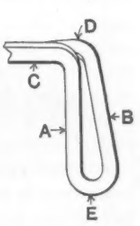


FIG. 36.

armature the coils adjoining each other really represent diametrically opposite coils when compared with a ring armature. It will also be seen that to wind such an armature properly it is necessary that the sides at which the ends of the coil come out should alternate, that is if the first coil has its ends at one side,

the second must have them at the opposite side, this order being preserved all the way around the circle. Both ends of each coil must come out at the same side, and if this is done the ends of the adjoining coils can be connected together, just as in the case of a ring armature. The ends of the coils can be brought out one on each side of the diameter, but if it is done it will complicate the connecting of the ends thereafter. The Edison machines are connected in this manner, but the universal practice is to have both ends come out at the same side. Fig. 33 shows the way of winding when the coils are all in a single layer, but it is sometimes desirable to place them in two layers, and when this is the case the winding will be as shown in Fig. 34. The only difference between these two is that the coils whose ends come out at opposite sides of the diameter are wound one on top of the other, instead of side by side. Coil 1 is on the outside with its ends 3, 4 at the top, and coil 2 is the under one with its ends 5, 6 at the bottom.

When the drum winding is used on multipolar armatures, the coils are not carried around to the opposite side of the diameter, as this is not only unnecessary, but very undesirable. As in multipolar machines the adjoining poles are of opposite polarity, the return side of the coil need only be carried as far around the circle as the next pole, that is, in a four-pole machine, one-quarter of the circumference; in an eight-pole machine, one-eighth, etc. In order to wind coils in this manner, and not have the wire pile up in an irregular manner at the ends of the armature, it is customary to form the coils into a regular shape, this shape being such that they will all fit into each other when placed on the armature. A coil of this class for an eight-pole armature is shown in Figs. 35 and 36. The part A belonging to the side C is bent so as to lay close to the core of the armature, as shown in Fig. 36, and the side B stands far enough away to be able to pass over A. It will be clearly seen that if another coil of the same shape as that shown is placed in the grooves to the left, it will fit in without interfering with the adjacent coils.

When an armature is wound with made-up coils, if it is to be connected in parallel, the ends of the wire are brought out at some convenient point near the bottom, marked E, in Fig. 36, and then the inside end of one coil is connected with the outside end of the adjoining one, the two ends being connected with the same commutator segment. This order of connection is followed all the way around the circle. If the series connection is to be used, the ends of the coils are brought out at the sides C D, and then are connected with the ends of coils from which they are separated by a distance equal to the distance between the sides C D, the connection with the commutator being at a point between the two coils whose ends are connected. The exact position of the commutator segment with reference to the armature coils will depend upon the position of the brushes, if they are to be in a line with the center of the space between the poles; the segment will be midway between the two coils, and will be shifted from this position just as much as the position of the brushes is changed.

Having explained the different styles of armature windings, we will now show how the number of lines of force developed in the field magnets can be calculated, and will then describe the various types of field windings. In the diagram, Fig. 37, M represents the field magnet with poles N S, between which the armature A is placed. A coil of wire is wound around the magnet, and the passage of a current through this, develops the magnetic force. If the current circulating in the coil remains unchanged, the strength of the magnet will be reduced if the armature A is removed. The explanation of this is that the resistance that air offers to the passage of the lines of force is very much greater than that of iron, and when A is removed, the lines have to pass through air from the surface of the N. pole to the surface of the S. pole, whereas if the armature is in place they simply have to cross over the two B spaces. Inasmuch as air offers more resistance than iron, it follows that the narrower the spaces B, which are called the air gap, are made, the stronger the magnet, the current through the coil wound upon it remaining the same. The resistance of air to the magnetic flow remains unchanged at all rates of magnetization, but that of iron and steel does not, it gradually increases as the magnetic strength rises.

In order to be able to determine the degree of magnetization developed by an electric current circulating around a magnet, it is necessary to know what relation exists between the magnetizing force and the resulting magnetic force. It has been reasoned out theoretically and demonstrated by actual experiment, that there is a fixed relation between the strength of current circulating around a magnet and the number of lines of force developed thereby. The current around the magnet is measured by the number of turns of wire in the coil and the number of amperes of current, and is expressed as so many ampere turns. If a coil has one hundred turns of wire, and the current passing through it is ten amperes, the total number of ampere turns in the coil will be one thousand. If the coil has one thousand turns of wire and the current is one ampere, the ampere turns will also be one thousand. From this it will be seen that *the ampere turns is the produce of the number of turns of wire in the coil multiplied by the number of amperes of current flowing through.* The number of lines of force developed by the magnetizing current is dependent upon the material composing the magnetic circuit, and also upon the length of the latter. As has been stated in a previous paragraph, the resistance of air is practically constant; therefore, to double the number of lines of force in a magnetic circuit, composed wholly of air, would require twice the number of ampere turns. Iron and steel do not offer a uniform resistance to the passage of the lines of force, on the contrary it becomes greater as the strength of the magnet increases; therefore, to double the number of lines of force in a magnetic circuit composed wholly of iron or steel will require more than twice the number of ampere turns. When the magnetic force developed is very weak, the difference between the resistance of air and iron is very great; for example, to develop a density of 5 000 lines per square inch of cross section in an air circuit requires a magnetizing force of about 1 600 ampere turns for each inch of length of the magnetic circuit, while in a wrought iron circuit it only requires one and six-tenths ampere turns, a difference of, say, one thousand to one. To develop 95 000 lines per inch in air, requires over 30 000 ampere turns per inch of length, and in iron 200, which in this case makes the difference about one hundred and fifty to one. From this it will be seen that for all rates of magnetization within practical limits, iron offers very much less resistance than air, but the difference between the two becomes less and less as the density of the lines of force increases. The relation between the lines of force and the ampere turns required to develop them is shown by the curves in Fig. 38. The curve A shows the number of lines of force developed in the best quality of Norway wrought iron, curve B those developed in mild steel castings, C is the curve for cast iron and D that of air. The numbers running along the under side of the diagram show the number of ampere turns per inch of length of the magnetic circuit, and the figures up the side show the number of lines of force per square inch of cross-section. The air line D, it will be noticed, is straight and very near to the bottom. It is straight because the number of lines developed in air rises uniformally with the rise in current, and it is very low down because it requires a very great magnetizing force to develop any considerable number of lines of force. The other three lines are curved, owing to the fact that the rate at which the lines of force increase is not in proportion with the increase in the ampere turns. The line representing cast iron, it will be noticed, is only about half way up to the other two lines, and from this it can be seen that a cast iron magnet can only develop about one half the strength of one made either of cast steel or wrought iron. With cast iron the lines of force increase very rapidly up to a point where the ampere turns become 20 per inch of length,

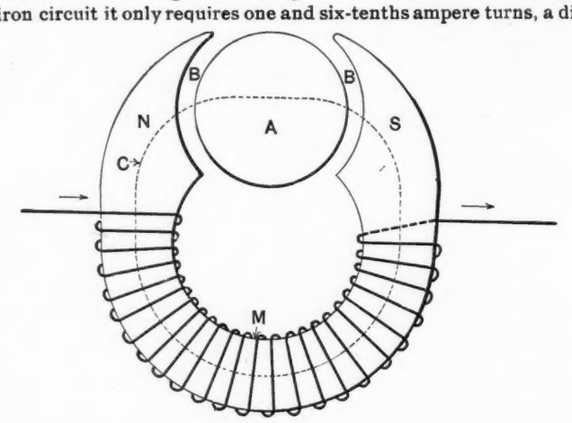


FIG. 37.

at which the magnetic strength is about 28 000 lines per square inch. Beyond this the rise is very slow, and if the ampere turns are doubled, the lines are only increased to about 35 000. With cast steel the rise is very fast up to a magnetizing force of about 40 ampere turns, at which point the lines per square inch are nearly 80 000, but beyond this the rise is even slower than in the case of cast iron, as doubling the ampere turns only increases the lines of force to about 87 000. With wrought iron the rise is very rapid up to about 30 ampere turns, which gives about 79 000 lines per square inch, and doubling the ampere turns only increases the lines to about 87 000.

From a study of these curves we find that up to a certain point a very small number of ampere turns will develop a great number of lines of force in iron and steel, but that beyond this point the increase is slow, hence it is not advisable to force the magnetization beyond the point where the curves bend around sharply and run nearly on a line with the air line. When a magnet is magnetized up to the bend in the curve, it is said to be saturated, and to endeavor to carry it beyond this point only results in a waste of magnetising current, as the gain is very slight.

The following table shows the number of ampere turns required per inch of length of magnetic circuit to develop any number of lines of force from 5 000 to 95 000 per square inch, in air, cast iron, cast steel, and the best quality of soft wrought iron:

TABLE OF AMPERE TURNS REQUIRED PER INCH OF LENGTH OF MAGNETIC CIRCUIT, TO MAGNETIZE AIR, CAST IRON, WROUGHT IRON AND STEEL TO DIFFERENT DENSITIES.

Lines of force per square inch of cross section.	Ampere turns required for Air.	Ampere turns required for Cast Iron.	Ampere turns required for Mild Cast and Sheet Steel.	Ampere turns required for Wrought Iron.
5 000	1 625	3¼	3	1¾
10 000	3 250	5¼	4	2¼
15 000	4 875	6¾	5	2¾
20 000	6 500	8	6¼	3½
25 000	8 125	10½	7½	4½
30 000	9 750	20	9	5½
35 000	11 375	38	10½	6½
40 000	13 000	65	12½	7½
45 000	14 625	110	14½	8½
50 000	16 250	160	16½	9½
55 000	17 875	300	19	10¾
60 000	19 500	500	22	12½
65 000	21 125		26	15
70 000	22 750		30	19
75 000	24 375		35	24
80 000	26 000		42	30
85 000	27 625		52	48
90 000	29 250		95	90
95 000	30 875		220	200

We are now possessed of all the information necessary to calculate the lines of force developed in the field, and to show how this is done we will give an example.

Suppose that in Fig. 37 we desire to develop a magnetic flux of 4 000 000 lines between the N. and S. poles of the magnet. Now as it requires a great many more ampere turns to overcome the resistance of the air gap than that of the iron, we will benefit by making the surface of the poles as large as possible, so as to reduce the number of lines coming from each square inch of surface. Suppose we make it such that the lines per inch are 40 000; then the pole surface will have to be 100 inches. If the width of the spaces B is half an inch each, the total air gap will be one inch, and we will require, according to the table, 13 000 ampere turns to force the lines across this space. Now as to the iron part, as the density of the lines can be increased to, say, 80 000, if we use steel or wrought iron, we can reduce the cross section of the magnet cores to 50 inches. To determine the number of ampere turns required to force the lines through this part of the circuit we must know its length, measured along the the central line C. As the poles are to have one hundred inches of surface, we can make them ten inches wide and ten inches around the circle, and if we do this the armature can be ten inches in diameter, which would make the distance from N. to S. eleven inches. This would make the distance around from N. to S. through the magnet about 39 inches, or a total length of 49 inches for the iron part of the magnetic circuit. As, from the table, the ampere turns required to magnetize steel up to 80 000 lines per inch is 42 per inch of length, the total number of ampere turns required for the steel part of the circuit will be $49 \times 42 = 2\,058$. Adding this to the 13 000 turns required for the air gap, we have a total of 15 058.

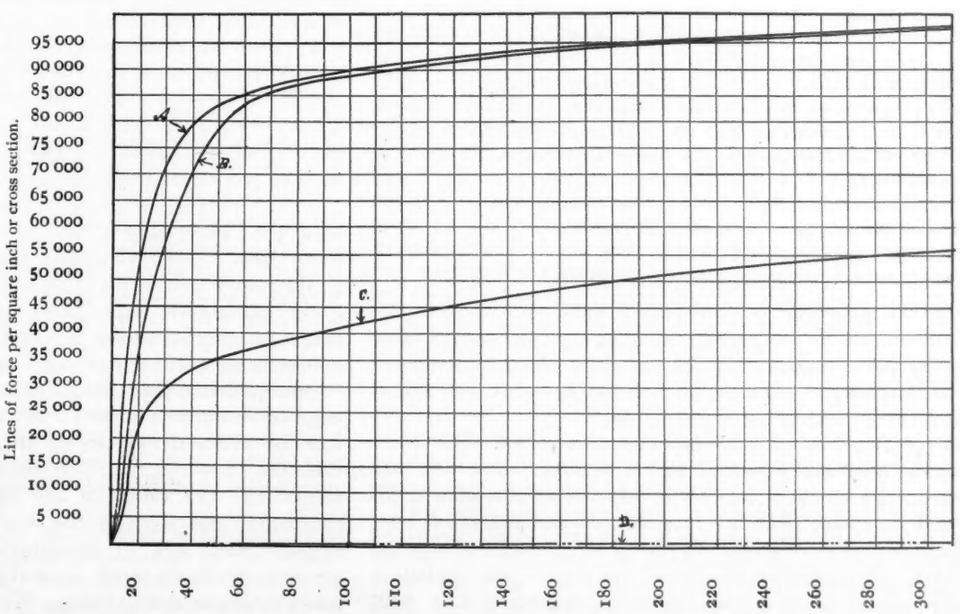
If we were to use wrought iron instead of steel, the number of ampere turns would be slightly reduced, as it requires only 30 ampere turns to develop 80 000 lines per inch in the former against 42 in steel; but this difference would only amount to 588 turns. If, however, we reduce the air gap to one-half its width, we will reduce the ampere turns to the extent of 6 500. This shows that it is desirable to make the air gap as narrow as possible, because it is here that the greatest amount of magnetizing force is expended. It is on this account that grooved armatures are used in every case where the difficulties of construction are not so increased thereby as to render their use undesirable.

It is desirable to make the magnetic circuit as short as possible, but reduction in the air gap is of the greatest importance. The amount of magnetizing force required to force the lines over the air gap can be reduced also by increasing the pole area, but this can only be carried to a certain extent, because an increase in this direction means an increase in the size of the armature, and this, if carried too far, will increase the cost of the machine beyond permissible limits, and in addition will increase the length of the armature wire, and therefore the resistance, unless the extra length is compensated for by greater thickness of wire, which means still more cost.

* * *

THE value of good engravings is often overlooked by manufacturers. Only last week the writer heard an observing business man remark, while he looked at the advertisement of a well known firm of lathe builders, "Those people build good lathes, but you'd never know it to look at *that*. Now, So & So (naming another equally well known concern) get out some mighty poor tools, but they look all right on paper."

An engraving cannot be too good (it may cost too much) if you want a machine to look attractive to a purchaser.



Ampere turns per inch of length of megnetic circuit to develop a given number of lines of force per square inch of cross section.

FIG. 38.

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OCTOBER, 1897.

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MACHINE COPYING.

In the last issue we commented upon one phase of this subject, and in the present number a correspondent takes exception to some things that we said. In continuance of the discussion we would like to ask on what grounds, if any, machine copying is justifiable.

It is true, as our correspondent suggests, that, when patent laws are provided and a designer does not take advantage of them, he has no reason to complain if his work is copied. But the fact that certain designs are not patented does not appear to justify the practice of copying them. The question is a moral, not a legal one, and before anyone can reach a just conclusion regarding it he must first form an opinion as to what is, and what is not, common property in machine design. In general, it would be just and fair to call a design "common property" if there had been long public usage, or opportunity for the same, though in many cases there would probably be other influential factors to be considered.

In this age very few really new mechanical movements are devised, and experts like Professor Reuleaux would probably tell us that even these could be reduced to elements that were known fifty years ago. Every designer, therefore, must utilize, or copy, the ideas of others to a great extent, and he is justified in this if he takes only such devices as may be considered common property.

Of the two methods of copying, viz., copying outright, or utilizing certain features only, and changing or originating other features, this much can be said: While we admire the open-handedness of the first, it is in fact what goes by the name of stealing in most departments of society, and as to the second, it probably should go by the same name; yet there is a possibility that the copyist may originate enough in the process so that the design may be his own to a certain extent.

One thing can always be done by anyone who wishes to be just in his work. He can give credit where credit is due. If Jones makes a steam engine and Smith copies the valve gear, it will not hurt Smith's chances to call his machine the Smith-Jones engine.

* * *

DOES TECHNICAL EDUCATION PAY?

The fact that the different colleges and technical schools are now opening their doors for a new year of study brings to notice two great changes that have taken place in college education, which have been very noticeable during the past fifteen years. These are the increased attendance of students of small or moderate means, and the introduction of engineering and scientific courses which are supposed to be of a more useful nature than those of former years.

While the primary object of any course of study is, and ought to be, to give a general training on broad lines, the above noted changes indicate that the majority of those who now go to college hope to receive a certain amount of special training which shall directly aid them in their future work, similar to that given by a medical college, which fits its graduates, to a certain extent, for medical practice. In short, whatever thought concerning general training the student may have, he wants to know if his studies will pay him in dollars and cents.

As far as mechanical work is concerned there appears to be a difference of opinion regarding this point; many holding that everything that has to be done with or about machinery can be done better, or at least as well, by the man whose mechanical knowledge has been obtained from his own practical shop experience.

It can be stated as a general principal that what brings money is a knowledge of how to do things and the ability to do them. So far as results are concerned, it can make no difference where this knowledge or ability was acquired. Plenty of men who have come up through the shop have secured it and have been successful, and so have plenty of men who have had a technical education.

The question, then, seems to be: Where can the knowledge and ability be obtained to the best advantage? We have no hesitation in saying that under the right conditions the knowledge can best be obtained in the technical school and the ability in the shop. In many cases, of course, the obstacles in the way of the former are the expense and lack of preparation, but several schools are already doing much to make it easier for those who really desire to attend them. We should be slow to advise anyone to undertake a course of study when it would be likely to result in a sacrifice of health in the endeavor to pay his way. He had better try to get his knowledge in some other way. Aside from this restriction, we believe a course in mechanical engineering will pay anyone who already has, or is willing to get, the needed practical experience in addition.

STANDARD MEASUREMENTS.*

HOW THE LENGTHS OF THE METRE AND YARD WERE ARRIVED AT—WHAT THE STANDARDS ARE IN ENGLAND, FRANCE AND THE UNITED STATES—THE WORK OF ONE AMERICAN FIRM IN THIS LINE—HISTORICAL NOTES.

W. A. VIALL.

By examining the ruins of the ancients it has been found that they had standard measurements, not in the sense in which we are now to consider them, but the ruins show that the buildings were built according to some regular unit. In many, if not all, cases the unit seems to be some part of the human body or its parts, as the cubic, digit, etc., indicate. The "foot" it is thought first appeared in Greece, and the standard was traditionally said to have been received from the foot of Hercules, and a later tradition has it that Charlemagne established the measurement of his own foot as the standard for his country.

STANDARDS PREVIOUS TO 1800.

In England, prior to the conquest, the yard measured, according to later investigations, 39.6", but it was reduced by Henry I in 1101, to compare with the measurement of his own arm. In 1324, under Edward II, it was enacted that "the inch shall have length of three barley corns, round and dry, laid end to end; twelve inches shall make one foot, and three feet one yard." While this standard for measurement was the accepted one, scientists were at work on a plan to establish a standard for length that could be recovered if lost, and Huygens, a noted philosopher and scientist of his day, suggested that the pendulum, which beats according to its length, should be used to establish the unit of measurement. In 1758 Parliament appointed a commission to investigate and compare the various standards with that furnished by the Royal Society. The commission caused a copy of this standard to be made, marked it "Standard Yard, 1758" and laid it before the House of Commons. In 1742 members of the Royal Society of England and the Royal Academy of Science of Paris, agreed to exchange standards and two bars 42" long, with three feet marked off upon them, were sent to Paris and one of these was returned later with "Toise" marked upon it. In 1760 a yard bar was prepared by Mr. Bird, which was afterwards adopted as a standard later, as we shall see.

In 1774 the Royal Society offered a reward of a hundred guineas for a method that would obtain an invariable standard, and Halton proposed a pendulum with a moving weight upon it, so that by counting the beats when the weight was in one position and again when in another, and then measuring the distance between the two positions, a distance could be defined that could at any time be duplicated. The Society paid 30 guineas for the suggestion and later the work was taken up by J. Whitehurst with the result that the distance between the positions of the weight when vibrating 42 and 84 times a minute was 59.89358". The method was not further developed as far as I can find.

HOW THE LENGTH OF THE METRE WAS ESTABLISHED.

In 1790, Talleyrand, then Bishop of Autun, suggested to the Constituent Assembly that the king should endeavor to have the king of England request his parliament to appoint a commission to work in unison with one to be appointed in France, the same to be composed of members of the Royal Society and Royal Academy of Science, respectively, to determine the length of a pendulum beating seconds of time. England did not respond to the invitation and the French commission appointed, considered first of all, whether the pendulum beating seconds of time, the quadrant of the meridian or the quadrant of the equator should be determined as a source of the standard. It was decided that the quadrant of the meridian should be adopted and that .0000001 of it should be the standard.

The arc of about nine and one-half degrees, extending from Dunkirk on the English Channel to Barcelona on the Mediterranean and passing through Paris, should be the one to be measured. The actual work of measuring was done by Mechain and Delambre according to the plans laid down by the commission. Mechain was to measure about 25 per cent. of the arc, the southern portion of it, and Delambre the remainder; the reason for this unequal division was that the northern division had been surveyed previously and the territory was well known, whereas the southern part was an unknown country, as far as the measurement of it went, and it was expected that many severe difficulties would have to be surmounted. The Revolution was in progress and it was soon found that the perils attending the measurement of the northern part were greater than those attending the southern part of the territory. The people looked askance at all things that they did not understand, and Delambre with his instruments, was looked upon as one sent to further enthrall them. He was set upon by the people at various times and although the authorities endeavored to protect him, it was only by his own bravery and tact that he was able to do his work and save his life. The Committee of Safety ordered that Mechain and Delambre close their work in 1795, and it was some time afterward before it was resumed.

Having completed the field work, the results of their labors were laid before a commission composed of members of the National Institute and learned men from other nations, who had accepted the invitation that had been extended to them, and after carefully reviewing and calculating the work, the length of the meridian was determined and from it was established the metre as we now have it. A platinum bar was made according to the figures given and this furnishes the prototype of the metre of the present time. Notwithstanding all of the care taken in establishing the metre, from work done by Gen. Schubert of Russia and Capt. Clarke of England, it has been shown that it is not .0000001 of the quadrant passing through Paris, but of the one passing through New York.

THE STANDARD YARD IN ENGLAND—ITS LOSS AND RESTORATION.

Whether incited by the work of the French or not, we may surmise, but in the early part of this century the English began to do more work upon the establishment of a standard, and in 1816 a commission was appointed by the crown to examine and report upon the standard of length. Capt. Kater made a long series of careful observations determining the second's pendulum to be 39.1386" when reduced to the level of the sea. This measurement was made on a scale made by Troughton—who, by the way, was the first to introduce the use of the microscope in making measurements—under the direction of and for Sir Geo. Schuckburgh. In 1822, having made three reports, after many tests, it was recommended that the standard prepared by Bird in 1760, marked "Standard Yard, 1760," be adopted as the standard for Great Britain.

The act of June, 1824, after declaring that this measure should be adopted as the standard, reads in Sec. III.: "And whereas it is expedient that the Standard Yard, if lost, destroyed, defaced or otherwise injured should be restored to the same length by reference to some invariable natural Standard; and whereas it has been ascertained by the Commissioners appointed by His Majesty to inquire into the Subjects of Weights and Measures, that the Yard, hereby declared to be the Imperial Standard Yard, when compared with a Pendulum vibrating Seconds of Mean Time in the Latitude of London, in a Vacuum at the Level of the Sea, is in the proportion of Thirty-six Inches to Thirty-nine Inches and one thousand three hundred and ninety-three thousandth parts of an Inch; Be it enacted and declared, that if at any Time hereafter the said Imperial Standard Yard shall be lost, or shall be in any manner destroyed, defaced or otherwise injured, it shall and may be restored by making a new Standard Yard bearing the same proportion to such Pendulum, as aforesaid, as the said Imperial Standard Yard bears to such Pendulum."

It was not long after this act had been passed, if indeed not before, that it was known that the pendulum method was an incorrect one, as it was found that the errors had occurred in reducing the length obtained to that at the sea level, and despite the great pains that had been taken, it is doubtful if the method was not faulty in some of its details.

When the Houses of Parliament were burned in 1834, an opportunity was offered to try the method upon which so much time and care had been spent. A commission was appointed and to Sir Francis Baily was assigned the task of restoring the standard. He did not live to complete the task, dying in 1844. He succeeded in determining the composition of the metal that was best adapted to be used, which metal is now known as Baily's metal.

Rev. R. Sheepshanks constructed a working model as a standard and compared it with two Schuckburg's scales, the yard of the Royal Society, and two iron bars that had been used in the ordnance department. Having determined to his own satis-

* Part of a paper read before the Providence Association of Mechanical Engineers.

faction and that of his associates the value of the yard, he prepared the standard imperial yard, known as Bronze No. 1, a bronze bar 38 × 1 × 1 inch, with two gold plugs dropped into holes so that the surface of the plugs passes through the center plane of the bar. Upon these plugs are three transverse lines and two longitudinal lines, the yard being the distance from the middle transverse line—the portion lying between the two longitudinal ones—of one plug, to the corresponding line on the other plug. Forty copies were made, but two of these being correct at 62 degrees Fahrenheit, and these two, together with the original and one other, are kept in England as the standards for reference. In 1855 the standard as made by Mr. Sheepshanks was legalized.

ATTEMPTS TO FIX A STANDARD IN THE UNITED STATES.

The Constitution empowered Congress to coin money, regulate the value thereof and of foreign coins and fix the standards of weights and measures, but up to 1866 no legal standard of length had been adopted. In his first message to Congress Washington said: "A uniformity in the weights and measures of the country is among the important objects submitted to you by the Constitution, and if it can be derived from a standard at once invariable and universal, it must be no less honorable to the public council than conducive to the public convenience."

In July, 1790, Thomas Jefferson, Secretary of State, submitted a report to Congress containing two plans, both based on the length of the pendulum, in this case the pendulum to be a plain bar, the one plan to use the system then existing, referring it to the pendulum as the basis, and the other was to take the pendulum and subdivide it, one-third of the pendulum to be called a foot. The whole length was that of one beating seconds of time. He made a table to read as follows:

10 Points make a Line.	10 Decads make a Rood.
10 Lines make a Foot.	10 Roods make a Furlong.
10 Feet make a Decad.	10 Furlongs make a Mile.

Congress did not adopt his system, and as England was then working on the problem it was decided to await the results of its labors. In 1816, Madison, in his inaugural address, brought the matter of standards to the attention of Congress, and a committee of the House made a report recommending the first plan of Jefferson, but the report was not acted upon. In 1821, J. Q. Adams, then Secretary of State, made a long and exhaustive report in which he favored the metric system, but still advised Congress to wait, and Congress—waited.

WHAT THE STANDARDS ARE IN THE UNITED STATES.

The standard of length which had generally been accepted as *the* standard, was a brass scale 82 inches long, prepared by Troughton for the Coast Survey of the United States. The yard used was the 36 inches between the 27th and 63d inches of the scale. In 1856, however, "Bronze No. 11" was presented to the United States by the British government. This is a duplicate of the No. 1 Bronze mentioned above, which is the legalized standard yard in England. It is standard length at 61.79 degrees F., and is the accepted standard in the United States. A bar of Low Moor iron, No. 57, was sent at the same time and this is correct in length at 62.58 degrees F. The expansion of Bronze No. 11 is .000342 inch, and that of the iron bar is .000221 inch for each degree Fahrenheit. While the yard is the commonly accepted standard in this country, it is not the legal standard. In 1866 Congress passed a law making legal the metre, the first and only measure of length that has been legalized by our government. Copies of the metre and kilogramme, taken from the original platinum bar at Paris, above referred to, were received in this country by the President and members of the Cabinet, on Jan. 2, 1890, and were deposited with the Coast Survey. By formal order of the Secretary of the Treasury, April 5, 1893, these were denominated the "Fundamental Standards."

THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

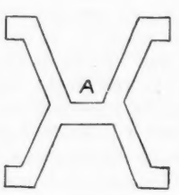
After the original metre was established, it was found that copies made by various countries differed to a greater or less extent from the original and believing that a copy could be made from which other copies could be more readily made than from the end piece metre, and that better provision could be made for the preservation of the standard, France called a convention of representatives from various states using the system, to consider the matter. The United States representatives, or commissioners, were Messrs. Henry and Hildegard, who met with the general commission in 1870. The commissioners at once set at work to solve the problem presented to them, but the Franco-Prussian war put an end to their deliberations. The deliberations were resumed later, and May 20, 1875, representatives of the various countries signed a treaty providing for the establishment and maintenance, at the common expense of the contracting nations, of a "scientific and permanent international bureau of weights and measures, the location of which should be Paris, to be conducted by a general conference for weights and measures, to be composed of the delegates of all the contracting governments."

This bureau is empowered to construct and preserve the international standards, to distribute the copies of the same to the several countries and also to discuss and initiate measures necessary for the determination of the metric system. The commission adopted a form for the standard as per sketch. The lines representing the length of the metre are drawn on the plane A, which is the neutral plane and will not change in length should the bar deflect. The bar is made of 90 per cent. platinum and 10 per cent. iridium, about 250 kilogrammes having been melted when preparations were made for the first standard, so that all of the copies made from this cast represent the same co-efficient of expansion and are subject to the same changes as the original. The French government presented to the bureau the pavilion Breteuil, opposite the Park of St. Cloud, which was accepted and put into order and is now the repository of the originals of the metre and the kilogramme. The expense attending the first establishment of the bureau was about $10 000 to the United States, and since then its share of the annual expense has been about $900. The standards in the possession of the United States were received through the international bureau.

THE COMMERCIAL VALUE OF A STANDARD.

Having at the disposal of the nation a standard of length, the question arises, "What can be made of it commercially and how do we know when we have a copy of the standard?"

In 1893, the Brown & Sharpe Mfg. Co. decided to make a new standard to replace the one they had at that date. Mr. O. J. Beale was detailed to do this work. He prepared steel bars about 40 inches long by 1¼ inches square, and after planing them they were allowed to rest for several months. At the end of these bars he inserted two gold plugs, the centers of which were about 36 inches apart, and a little beyond these two others about one meter apart. A bar was placed in position upon a heavy bed. This was so arranged that a tool carrier could be passed over the bar.



The tool carrier consisted of a light framework, holding the marking tool. One feature of the marking was that the point of the marking tool was curved and had an angle, so that if dropped it made an impression in the form of an ellipse. In graduations, ordinarily, the line, when highly magnified, is apt to present at its ends an impression less definite than in the center, by reason of the form of the objective. The line made with the tool, as stated, is short, and that portion of the line is read which passes, apparently, through the straight line in the eye-glass of the microscope. In order to make these lines as definite as possible, the point was lapped to a bright surface. After being placed in position, the microscope, which could be placed on the front of the tool carrier, was set to compare with the graduation on the standard bar from which the new bar was to be prepared. After such a setting the readings were made by three persons, and by turning the lever the marking tool was dropped, making a very fine line, so fine indeed, that when the authorities in Washington began the examination of the bar later on, they declared that no line had been made upon these studs.

After making the first line, the carriage was moved along to compare with the other line on the standard, and after the correction had been made by the use of the micrometer in the microscope, the marking tool was again dropped, giving the second line, which was intended to mark the limit of one yard over all. The same operation was repeated in the marking of the metre. The whole of this work was done, of course, with the greatest care, and, while the theoretical portion of it appears very simple in detail, it required a great deal of time and patience before the last line had been made. The bar thus marked was taken to

Washington, and in Mr. Beale's presence was compared by the attendants with Bronze No. 11 and later with Low Moor bar, No. 57.

In comparing this standard, a process was gone through with similar to that used in marking it. The bar, properly supported, was placed upon a box that rested upon rolls, and on this same box was placed the government standard with which the Brown & Sharpe standard was to be compared. The standard was placed in position under the microscope, and after being properly set to the standard, the bar to be measured was placed under the microscope, and by the micrometer screw of the microscope the variation was measured. Three comparisons were made by each of the attendants on each end before determining the reading of the microscope, and after such comparisons and many repetitions of it, the value of the standard No. 2 was found to be 36.00061 inches for the yard and M1.0000147 for the metre.

After this work had been done, Mr. Beale prepared a second standard, which he called No. 3, and after examining, as shown above, the error was found to be .00002 inches for the yard and M.000005 for the metre. Observing these variations as compared with the standards originally made, we find they are very close, and it is doubtful if many repeated trials would furnish more accurate work, when we remember that out of the forty original standards made, but two are correct at 62 degrees Fahrenheit.

After establishing a yard, the problem of obtaining an inch next comes, and this was made by subdividing the yard into two equal parts, these into three, and the three further subdivided into six parts. It should be particularly noted that no mention has been made of a standard inch, as there is none, the standard yard only existing, the subdivision of which falls upon those undertaking standard work. There is a remarkable agreement between at least three leading gauge makers of this country and abroad, and each came to the result by its own method of subdividing the standard yard.

PRACTICAL PATTERN MAKING.—5.

PATTERN WORK FOR LOAM MOULDING.

I. McKim Chase.

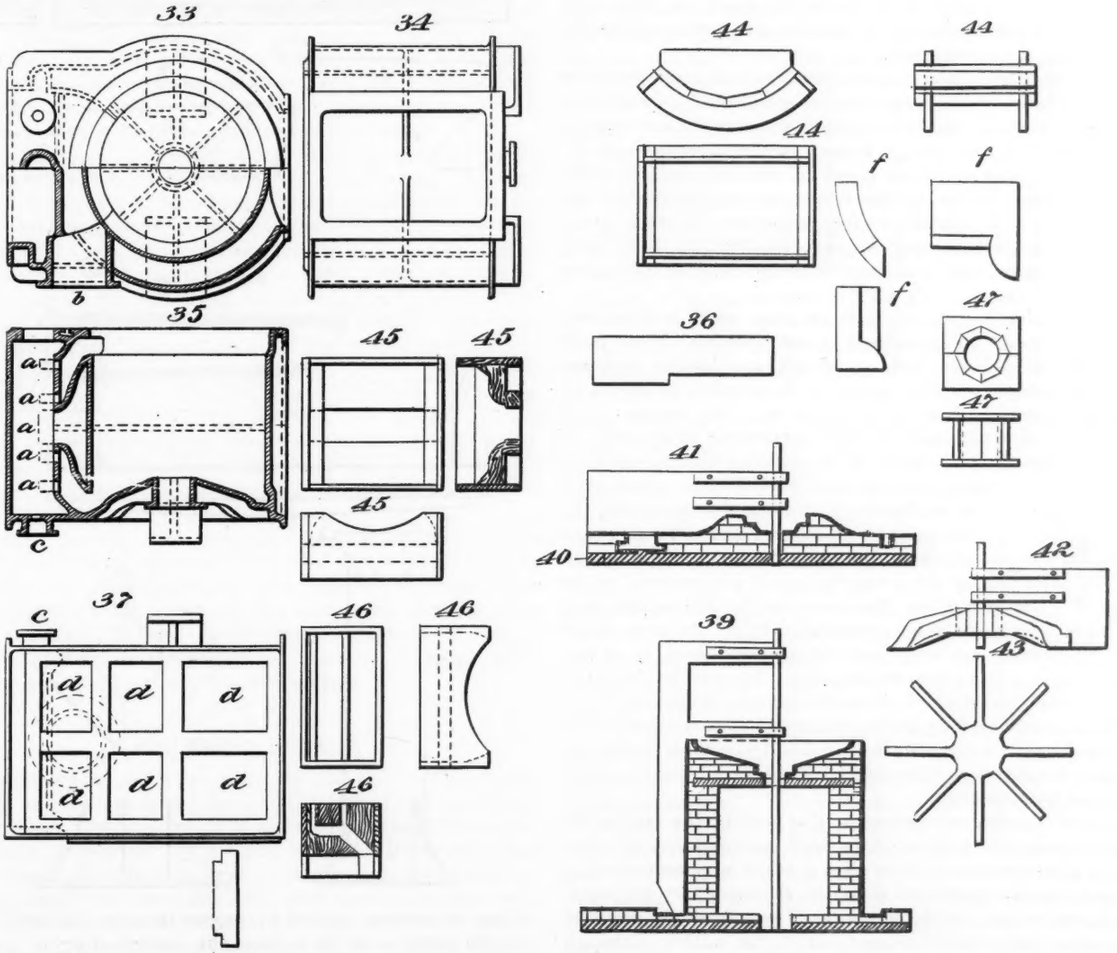
PATTERN WORK FOR STEAM CYLINDER OF MARINE ENGINE.

The pattern of a large steam cylinder, with steam and exhaust passages, when moulded in loam, demands a greater proportionate amount of detail than is required by those described already. The pattern work can be made more or less elaborate, according to the manner in which the moulder desires to proceed in order to construct the mould.

The following pattern work and method of procedure have been applied with successful results in producing satisfactory castings of large cylinders:

In the illustration, Fig. 33 shows a plan view, 34 an elevation, and 35 a section of a casting designed for a low pressure cylinder with receiver for a compound engine.

When a loam mould is to be made for such a cylinder, the pattern-maker is required to prepare the necessary pattern work before the moulder can proceed with its construction.



The cylinder is moulded inverted; that is, the open end, or that which is upward when it is in the engine, is moulded downwards.

The first piece required is the seat, or foundation sweep, 36. This sweep forms a level surface, upon which the pattern work is placed; and it also forms the flange facing, against which the cylinder head is bolted. Fig. 37 represents a framework of wood. Its exterior is the form of the exterior of the casting. It also contains the valve chest, which is the same in form as that represented in the sectional view, 35, except that where the openings are shown in the valve face core prints are placed, as shown by the dotted lines *a a*, etc., projecting from the valve face. These core prints are for the purpose of locating and supporting the cores for the induction and eduction passages. The cylindrical parts can be formed with revolving sweeps, secured to a spindle, which method is preferred by some moulders; but a framework of wood is preferable in cases of this character, as

with it there is less difficulty in retaining the parts in their proper positions. The flanges projecting inward in the valve chest are screwed or put on with draw-pins, in order that they may be released and withdrawn outwardly. The framework is made in sections and screwed together to facilitate its being taken apart and withdrawn from the mould. The patterns for the exhaust nozzle *b*, and nozzle *c*, are made blank and cored out with special cores inserted from the outside of the mould.

The foundation, or seat, being prepared and lined off, the framework is placed upon it and properly located. Everything is then prepared for the building of the cope, or outer wall of the mould, to be proceeded with. The framework has open places, as *d*, *d*, etc. When the mould is being built up past these places, a strike, 38, is used from the inside to shape these parts of the mould. When the exterior of the mould is completed to the top of the upper flange it is struck off by a plain sweep fixed at right angles to the spindle. A line is drawn across the top of the mould through the center of the cylinder and valve chest; and another line at right angles to the former and through the axis is also scribed on the top of the mould. These lines are for the purpose of locating the position of the covering plate of the mould. When the exterior of the mould, which has been made in sections, is sufficiently dry to handle, it is removed from the seat, leaving the latter intact.

The framework is then removed from the seat, after which the main cores sweep, 39, is secured to the spindle and the main core built up on the seat, where it is dried and dressed and remains undisturbed. A core seat is formed in the upper part of the main core, into which a core is set to core out the hole in the head of the cylinder for the plug which contains the stuffing-box for the piston-rod. Previous to setting the core the main core is filled with sand, as a precaution against accident, the metal being liable to make its way into the interior of the core during the filling of the mould.

The cover of the mould, or cope plate, as it is sometimes called, is made to form the head of the cylinder. It is a plate provided with prickers, and is specially cast for the purpose. When preparing the mould upon it it is inverted, as shown at 40, and a spindle is erected at its center. The sweep, 41, is secured to the spindle, and a surface conforming to the shape of the top of the ribs and flange of the cylinder-head is swept up. The parts of the casting which project beyond this surface, such as the flange of the stuffing-box for the valve stem and the brackets by which the cylinder is secured to the housing, are represented by patterns which are accurately located and bedded into the loam during the sweeping up of this surface by the sweep 41. The pattern for the nozzle for the stuffing-box plug and the radiating ribs being prepared, they are properly placed upon the surface last swept up, and another sweep, 42, is employed to sweep off the top of the cores. The ribs for the cylinder-head with the sweep 42 are shown apart from the plate at 43. When the mould on the plate is finished, it is marked with lines at right angles to each other to correspond with those scribed on the top of the exterior of the mould. The covering plate is set on the mould by these lines.

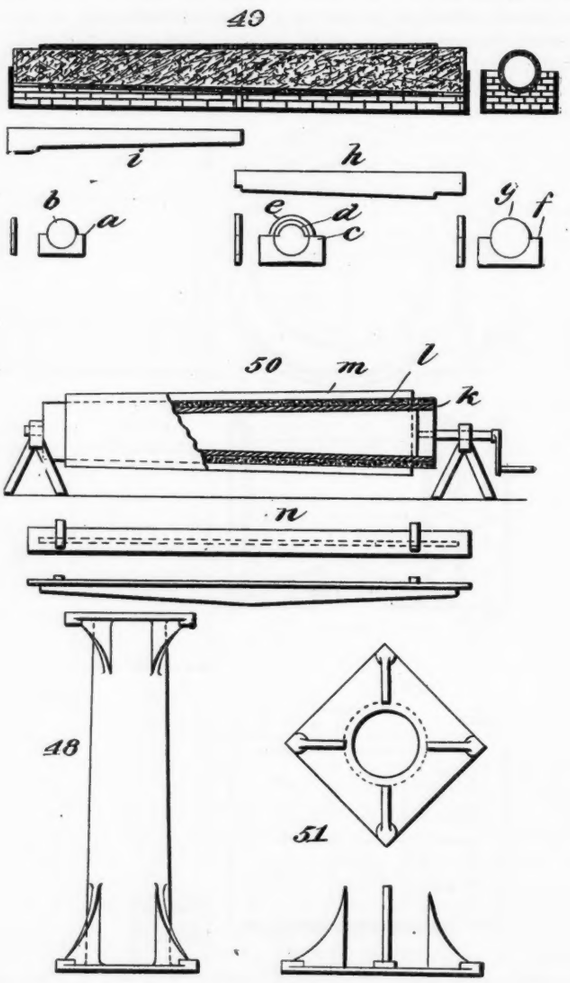
The core to form the receiver, or that part of the casting between its inner and outer walls, in some cases is the usual brickwork of loam moulds; in other cases a series of cores made in a box and joined together to form the required part are used. This latter method is preferable, as it possesses the merit of being much more easily cleaned out of the casting, although greater care is required in preparing the vents.

At 44 are shown three views of a core-box for receiver cores. The cylinder herein described will require eight of these cores, two in height and two around each side. The box is made a segment of ninety degrees, but the cores complete will not extend so far. They are made the required size and shape to fit the mould by placing stopping off pieces in the ends of the box. *f* shows such a piece for stopping off the cores. Where the exhaust emerges it requires two of these pieces, one right and one left-hand. Two more of the proper form, right and left, are required to stop off the cores which go to the open side opposite the valve chest. Fig. 45 represents the box in which the core for the exhaust passage is made. Three views are shown—plan, elevation and section. The box is made to be taken apart.

Fig. 46 shows the box in which the cores for the steam passages are made. These passages are of the double-ported variety. Three views of these are shown—plan, elevation and section. Fig. 47 represents the core-box for coring out the cylinder-head nozzle into which is fitted the plug containing the stuffing-box for the piston-rod.

PATTERN WORK FOR A PEDESTAL.

Occasionally a large casting of some kind is called for, a duplicate of which is never likely to be required. To make in the usual way a pattern for such a casting would consume considerable time, which might cause delay as well as involve unnecessary expense. In such cases, therefore, recourse is had to temporary expedients. Fig. 48, in the second illustration, illustrates such a casting in the form of a tapered pedestal, whose length and comparatively small diameter are such as to make it inadvisable to sweep it up vertically, after the manner of making a cylinder mould, or to incur the expense of constructing a pattern of the usual kind. It being decided to cast the pedestal in a horizontal position, a barrel, upon which the core is made, is the first piece required. The pattern for the core barrel will be formed by



strikes, or sweeps, guided by proper templet, the skill of the moulder being called in to form the pattern after the pattern-maker has provided the necessary appliances. Fig. 49 illustrates a section of the mould and pattern for the core barrel. An iron flask is first constructed, which, when very long, as in the present case, is made in two pieces. The usual brickwork of loam moulds is built inside the flask, and the guide *a* is set at one end of the drag, the guide *f* at the opposite end, and guide *c* midway between the two. When thus arranged, their circles are such that when a straight-edge is moved around the inside, the required uniform taper will be produced. The middle guide is not absolutely essential, but with it the strike need be only one-half the length of the mould, thus being more conveniently handled. *h* is the sweep for forming the lower or drag half of the mould, and being half the length of the latter, it is used alternately at each end. The recess in the mould formed by the offset on the sweep *h* represents the thickness of the casting. When the mould is sufficiently dry, this recess is filled in with green sand, and a straight-edge moved around the guides reduces it to the

proper thickness. This last operation completes the lower half of the mould and pattern. The core is next made on the inside of the mould up to the joint. The guide *b* having been set in *a*, and *g* in *f*, these determine the diameter of the upper half of the core. The half collar *d* is set midway between the other two for the convenience of a guide for the sweep, which is a straight-edge, of half the length of the mould. When the core is formed the collar *d* is removed and its impression in the core filled in. The core being sufficiently dry, the half collar *e* is set midway of its length, and green sand is placed around the core; the sweep *i* is then used to reduce the sand to the thickness of the intended metal. This completes the core and pattern for the upper or cope half of the mould. The mould is then completed in the usual manner. The illustration shows the various guides and sweeps for the core in the relative positions which they occupy in the mould, but separated from it.

When the mould is taken apart and the core lifted out, the thickness of green sand is removed, and the mold and core are then finished in the usual manner. Numerous small cores, the same length as the thickness of metal, are fixed around the mould for the purpose of casting holes in the core barrel. The core barrel *k* being cast, is mounted between bearings, as illustrated at 50. The core is made in the usual manner by winding the barrel with rope made of hay, then coating this with loam *l*, and reducing the loam to the required size and shape by revolving the core while in contact with one side of the sweep *n*, which is set so as to obtain the proper diameter of the core.

When the core is sufficiently dry, which is accomplished by building a fire under it while it remains in the bearings, a second coat *m* of specially prepared loam is laid on and brought to the required thickness, which is equal to that of the metal, by revolving the core, while the reverse edge of the sweep *n* is fixed so as to reduce the loam to the required diameter. This being accomplished, the second coat forms the pattern for the body of the pedestal. When this outer coat is dry and dressed, it is ready to receive the top and bottom flanges 51, ribs, bosses and whatever else is necessary to complete the pattern.

These parts are made of wood, and are fitted to the pattern formed for the body of the pedestal, the flanges parting through thei rcenter and the bosses arranged so that they can be drawn in through the vacancy left by withdrawing the flanges.

The pedestal pattern is supported in a horizontal position when it is being moulded, the supports being under the gudgeons which project from the ends of the core barrel. The mould is constructed of brickwork in the usual manner of constructing loam moulds. When the mould has been completed and taken apart, the coating of loam representing the thickness of metal is removed from the core and the latter dressed. After the mould has received like treatment it is reassembled.

* * *

FINISHING WORK.

Probably no one department in a machine shop will pay larger returns on the investment than a well equipped buffing and polishing room. The equipment is comparatively inexpensive and the output per machine and per man is large. Moreover, it does work, which, when done by hand at the bench, is of the most expensive kind. Whenever one finds men standing at the bench filing and polishing machine work, he can be sure that there is a big leak, which ought to be stopped. When a buffing room is once started, it is surprising to find how much can be done there. Not only can bright parts that have been regularly machined and finished by hand be polished there, but we have known where certain wearing surfaces on cheap machinery were finished entirely on the emery wheel. While this practice is not to be commended, it goes to show that with a little ingenuity in devising attachments, good and even work can be turned out.

In these days, when finish is left off of every part of a machine except the wearing surfaces, and in many cases there is none too much on them, we are inclined to look on it as something entirely out of date and out of place. When such work was done by hand, there was very good reason why a reaction should set in and we should come to this conclusion. But is there not danger of going to an extreme in this? When finish can be put on in so many places at so small a cost, would it not pay to do so? This is one result, anyway, that might be realized by establishing a buffing room.

A POINT ON PATENT APPLICATION.

C. L. Redfield.

I recently had occasion to prepare a patent application on a certain bicyle attachment for a client of mine. In due course of time the claims of this application were rejected on a reference to a patent obtained by a previous inventor. A copy of this patent, together with a sample article made by the patentee, lies at my elbow as I write. A comparison between the two devices shows that they are almost identically alike, though there are some minor differences in the details of construction.

Looking at this prior patent from the standpoint of a mechanic, it is easy to see that the inventor, in making his model device, drilled a hole through the two halves where they came together, and inserted a pin to hold them, for the evident purpose of testing its operation. Examining the patent further for the purpose of seeing its scope, it is evident that the drawing was made from this model, and that the attorney who drew the one solitary claim was so anxious to get it allowed that he made it depend upon this hole drilled in the two halves in the manner described. Comparing the two devices with the patent, it is seen that neither has this particular feature, and consequently my client does not infringe the patent, and the patent does not protect the original inventor in the manufacture of his device.

It will therefore be apparent that this patent is not only worthless to the patentee, but stands in the way of a subsequent inventor. As there was no other reference of importance it is a wonder how the first inventor of a new device should get a patent that is not worth the paper it is written on. A glance at the lower right hand corner of the drawing explains the whole thing, for there is the name of a certain firm of patent attorneys who do a gigantic patent soliciting business in all parts of the United States, and who have this business attended to by a force of clerks. The particular clerk who attended to this case must be a valuable one, for he succeeded admirably in getting the patent allowed on the first action, thereby saving office work and consequent expense to his employers. It is true that he did not look well after the interests of his client, but he was not interested in the success or failure of this particular bicycle attachment, while he was interested in establishing a record for rapidity and efficiency in disposing of patent cases placed in his hands.

The moral of this is not that an inventor should refrain from obtaining a patent on a meritorious device, but that he should select an attorney who will give his own time and attention to the mattter instead of delegating it to a mere clerk. There are plenty of such in this country, and while there are no particular objections to employing an attorney at a distance, it is usually better to employ one located within easy reach of the inventor. All business with the Patent Office must bc done in writing, and a letter from Chicago or San Francisco has just as much force as one from Washington.

The Patent Office, in its official publication, in speaking of attorneys, says that it is "unsafe to trust those who pretend to the possession of any facilities except capacity and diligence for procuring patents." To this it may be added that it is unsafe to trust those who offer to give something for nothing, who advertise "No patent no pay," or who pretend to anything else than good conscientious services for a reasonable compensation.

A patent is a deed for an invention, and unless the patent properly describes and claims the invention, the deed becomes worthless. The qualifications, therefore, of a good attorney in the prosecution of a patent application are a sufficient acquaintance with mechanics to enable him to see the real essence of the invention, ability to state what the real invention is, so that its relationship to the mechanism in which it is embodied can be clearly understood, and enough knowledge of the law to enable him to prepare the required documents in the proper form. Of these three elements, the first is the key to the situation, for, unless the attorney can see the spirit of the invention, he cannot prepare the patent so as to protect the inventor.

Crude and insignificant constructions sometimes contain the germ of important inventions, and in such cases even the best attorneys are occasionally lame. How much more must it be with mere clerks, whose only ambition is to turn the matter over and get rid of it? Clerks are useful and desirable in their proper spheres, but preparing patent applications is not one of them. It is the poor and often gullible inventor, and not the rich corporation, who is willing to trust a case in such hands.

A SHOP WITH A HISTORY.

THE PUTNAM MACHINE COMPANY, FITCHBURG, MASS.—ONE OF THE FIRST SHOPS IN THE COUNTRY TO DO GOOD MACHINE WORK.

A Hardcase.

The Putnam Machine Company have just such a plant as one might expect them to occupy after an experience of more than sixty years as builders of machinery and engines, and whose present plant consists of buildings that were erected many years ago as permanent structures, and enlarged from time to time as the business prospered under the able management of its founders, John and Salmon W. Putnam.

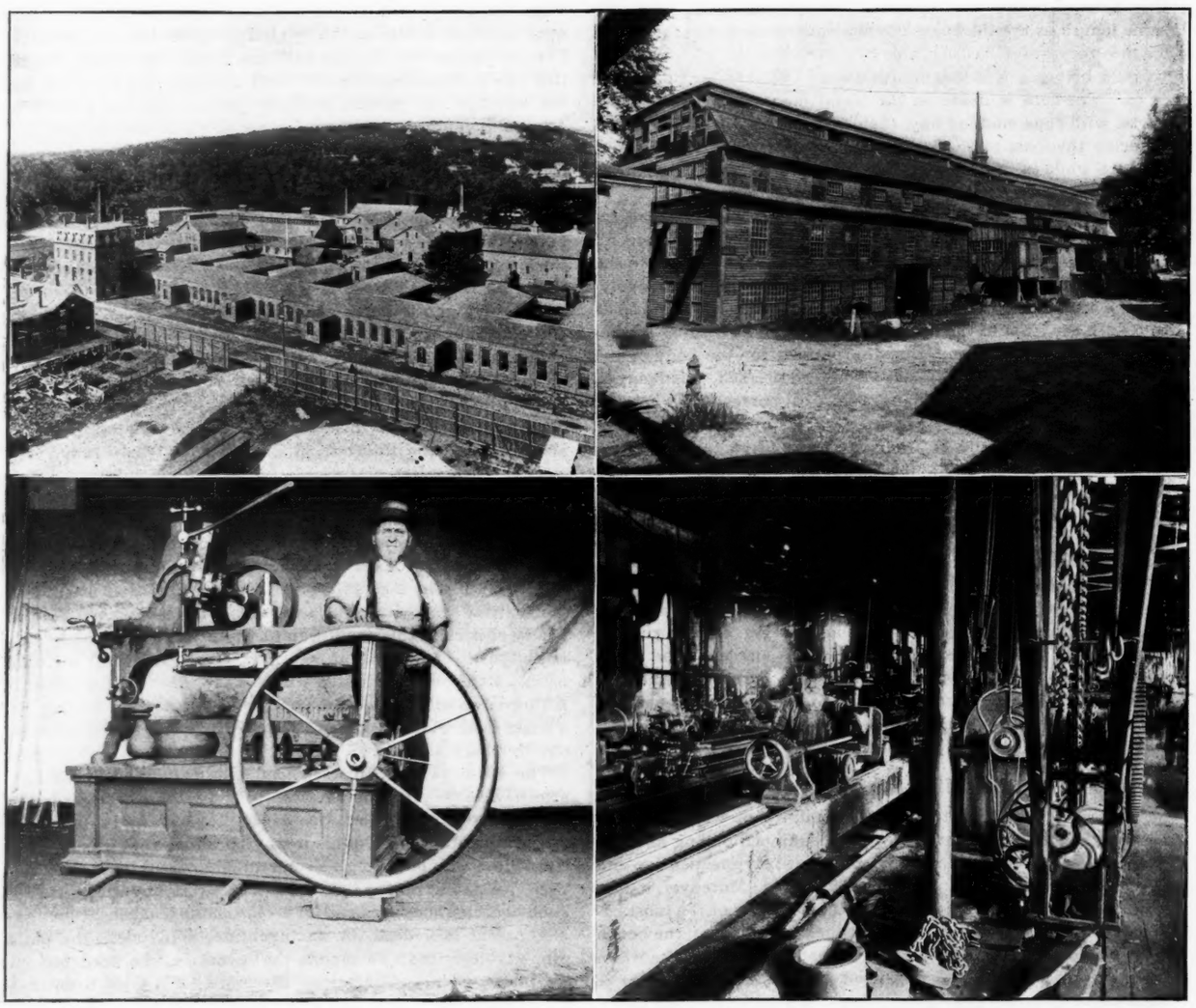
Situated as they are in the business section of Fitchburg, a balloon would be necessary to obtain a view that would include this fourteen acres of buildings in a single photograph.

railroad, from which a spur has been run down into the back yard of the foundry and along close to the front of the storehouses which constitute the next row of buildings. Beyond these are still more buildings, one of which was bought and pressed into use when business demanded the room. This building, formerly a cotton mill, has seen nearly a century of service and is now used as a planing mill.

The three story brick office on Putnam street was recently moved to its present location from the extreme end of the long shop and the lower story added, in which a bath room and other conveniences are being finished. This is the four-story building shown in the left of the general view.

HOW THE PUTNAMS STARTED.

At eight years of age S. W. Putnam left home to earn his own living and served several years as bobbin boy in a New Hampshire cotton mill, after which he obtained a position with one of



WORKS OF THE PUTNAM MACHINE CO.
EARLY GEAR CUTTER AND THE MAN WHO WORE IT OUT.

THE OLD COTTON MILL—1812.
MR. FARRAR AND AN OLD SHAFTING LATHE.

The principal part of the machine work is done in the main shop, which is 625 feet long and 48 feet wide, on the back side of which are seven L's, each of which is used for an erecting shop for some particular kind of machinery, while the offices for the foremen are in the five smaller L's on the front side. By this arrangement of departments the erecting is located close to the section in which the parts are made, and under the direct supervision of the foreman, while all of the shafting and running machinery can be compactly placed in the body of the building, which has no dividing walls. The offices, blacksmith shop and one engine room are near one end of the long shop.

Back of this row of buildings is another in which are the tool making room, pattern shop, brass foundry, stores, etc., with the large iron foundry in their rear near the tracks of the Fitchburg

the large manufacturing corporations in Lowell, Mass., where he was appointed overseer of the spinning room at seventeen and saved enough money to attend three terms at Appleton Academy in New Ipswich, N. H., before beginning work for his elder brother at the age of nineteen.

John Putnam was born 1810 at Peterboro', N. H., and was closely connected with Generals Israel and Rufus Putnam, who were prominent in the revolution. His father and grandfather were both scythe makers, and as his father's assistant he learned his first lesson in metal working. At fourteen he began his apprenticeship of five years in the machine shop of Loammi Chamberlain, Greenville, N. H., working fourteen hours per day with the privilege of four weeks' schooling, but working before and after school.

After his apprenticeship he remained with his employer and received one dollar a day for his services. In 1835, however, he hired a part of his employer's machinery and tools and began building cotton machinery, taking his younger brother, S W. Putnam, as an apprentice. The following year found them building machinery with which to start a machine shop in Trenton, N. J., but owing to the panic of 1837 the plan was abandoned, and after working a few months as repair hands in a cotton mill, their machinery was used to equip a shop at Ashburnham, Mass. Here the two brothers started in business

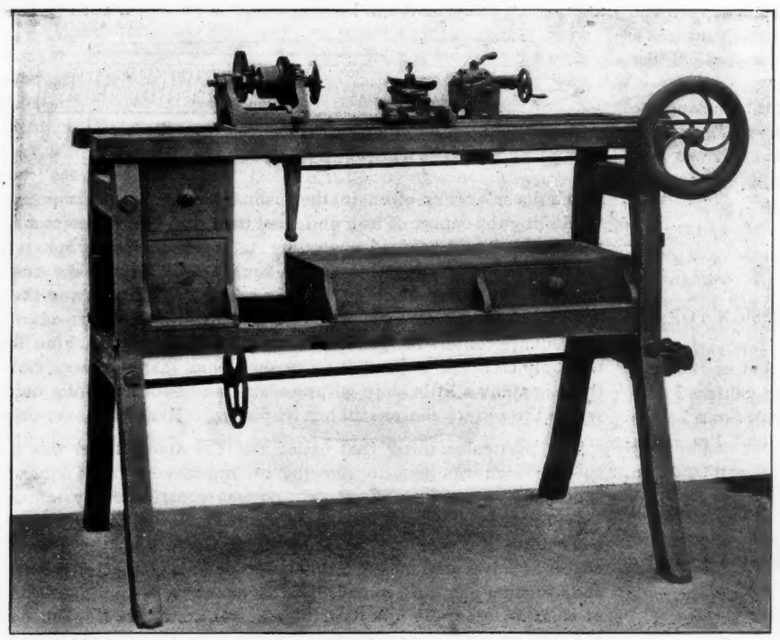


FIG. 5.—THE FIRST PUTNAM LATHE.

as J & S. W. Putnam, and with the following list of tools: one 24" lathe, two small screw cutting lathes, one chucking lathe, one polishing lathe, one upright drill, two die stocks, taps, dies, reamers and mandrills. About a year later they hired a room 20 x 30 feet and transferred their business to Fitchburg in 1838, where, as a repair shop, it provided employment for themselves only until they began building new machinery. Soon after a gear-cutter was designed and several of them built, and they continued to manufacture machines of the same general type until about twenty years ago.

In December, 1849, a fire destroyed their uninsured plant which represented about $12,000 worth of hard-earned property, but they resumed business in a temporary building within a few weeks, and the present Putnam Machine Co., with three sons of its deceased founders at its head, is the result.

The facts that they started so young and with almost no money or education and accomplished so much by their ingenuity and strict attention to business, show that it is possible for a good mechanic to possess executive ability, and better still was the compliment added by one of their aged workmen after his many years of service when he told me that "Salman W. Putnam was one of the best men that ever lived."

THEIR EARLY WORK.

At one time the Putnam Machine Co. was one of the few in the United States who were turning out good work in their line, and among some of the inventions that were never patented, but are credited to its ingenious founders, are the self-adjusting box and hanger, which they still make, the movable and adjustable table for upright drills, the feed rod for engine lathes, the open adjustable back rest for lathes, the combination cutting-off and splitting saw bench, etc.

Many of their old hands, whose skill and years of faithful service no doubt contributed much to the success of the company in the past, are still to be found in the works. Mr. George Farrar, who has been employed as a lathe hand since October, 1845, began work on a Putnam lathe with wooden bed and iron ways, and still uses it as an auxiliary to its modern counterpart.

The bench centers, hanging on the wall opposite Mr. Farrar's lathe, attracted my attention. Their foot-prints in the solid brick wall were more than an inch deep, and tell—as near as any one will ever know—how many times they have been taken down and replaced.

Mr. George H. Boss was hired two years later, and wore out one of their first lot of gear cutting machines and is still cutting gears for them. I found the old machine in a neglected corner and, through the kindness of the company, it was rolled out to be photographed with its surviving operator.

The index plate of this gear cutter, made about 1852, contains 52 rows of holes, as follows:

144	190	236	276	336	376	420
148	194	238	284	340	384	428
152	202	242	292	344	392	436
160	208	246	300	348	399	444
164	212	250	308	352	400	452
178	220	252	316	360	408	460
180	228	260	324	366	412	468
		268	332	372		

Total, 15,690 holes.

THE FIRST LATHE.

What is claimed to be the first Putnam lathe, built by J. & S. W. Putnam in 1835-6, is an interesting relic to be found at the Putnam Machine Co.'s. The legs and bed are of wood, with iron ways, and it has only one belt speed. Instead of the usual eccentric motion for disengaging the back gears, they are slid along on their shaft. The shaft and pulley seen under the lathe are driven from a small grooved pulley on the back gear quill, and this rod drives the three small gears shown on the right. Two of these gears have a worm on the same shaft with a worm gear between them. From this worm gear and its vertical shaft the hand-wheel shaft is driven by bevel gears. Fastened to the carriage and running in a pinion on the hand-wheel shaft, is a rack that pushes or pulls the carriage along in a direction depending upon which one of the worms is engaged with the worm gear, which is controlled by the lever and rod shown just below the lathe bed. Three notches are provided where the lever passes up through the lathe bed near the headstock, and when it is stopped in the intermediate position, the worm gear is also midway between the two worms, leaving the carriage free to be operated by the hand-wheel by rack and pinion, like a common turret lathe or screw machine.

The carriage has a cross-feed screw and stop, and is elevated at the back by a screw bearing directly on the way, but probably had a small block under it once. It was evidently built when lathe carriages were mounted on a round top way in front, instead of a saddle with cone-pointed screws, as some are at present.

LATHE BUILDING AT PRESENT.

Lathe building, which has been carried on continuously by the Putnam Machine Co. during their long business career, still continues to be a large part of their business.

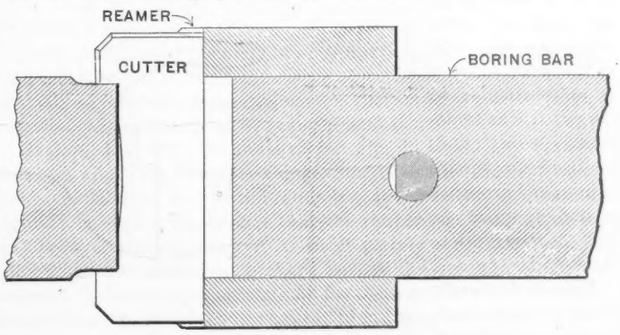


FIG. 6.—CUTTER BAR AND REAMER.

The hollow spindles are bored with a fluted drill in a power feed machine holding the work in a vertical position above the drill while it revolves, so that the chips will have less tendency to clog.

In squaring up the ends of their heavy lathe beds a milling

fixture is used, which is fastened to the planer head and the cutter driven from an extra counter shaft overhead. It seems as if this plan could be used to advantage to finish many heavy pieces at one setting, especially on large awkward parts that are difficult to place.

A tool for some of the rough jobs of boring is shown in Fig. 6; this consists of an ordinary boring bar and cutter with a shell reamer behind, and both held in place by a single key, the cutter being the driver for the reamer.

Studs with flattened bodies that are to be used in a slot are milled with angular cutters fed towards the shoulder instead of across it, so that the milled part of the shoulder is cupped out without danger of mutilating its turned surface, which insures a good square seat at right angles to the body of the stud. I like to see such care devoted to details.

It is stated that this company equipped the first two complete machine shops in China with steam engines, shafting and hangers, lathes, planers, drills and tools complete. It was also the mission of this company to manufacture the compressors and rock drills used in completing the Hoosac tunnel.

* * *

SQUARE CENTERS.

A LETTER EXPLAINING THEIR USE—A NEW DESIGN FOR AN OLD-STYLE TOOL.

I don't know whether it's a compliment or not, but as the new editor has asked me to write something on square centers I suppose I must. He says he never used a square center and knows lots of others who never have. Well, I have, and I'm not a Methuselah, either.

Fig. 1

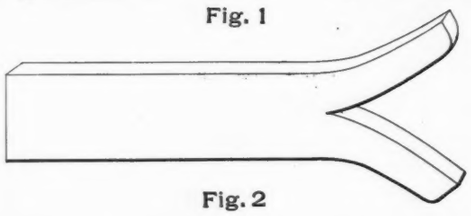


Fig. 2

Square centers for general work are out-of-date and have given way to the more civilized and more economical drill and center reamer combined, although this was not the first step out of the square center wilderness. The medium stage was the separate drill and the half-round center reamer.

The square reamer was a round piece of steel (usually), with one end ground down like *a*, Fig. 1. It was like this to begin with. Later in life it would get ground down like *b*, and then the work would fly while it was being centered and also while it was being turned. The writer once had to turn up a lot of handles on the ends of some cast iron levers, and as the work was not at all particular, so long as it was somewhere near round, he used the square center, and probably would again if he had the same job to do.

A piece of wrought iron, or soft steel, about ½ x 1 inch and 6 inches long was obtained and the end opened out, as at Fig. 2, for a "coaxer" to induce the work to find its approximate center while the cutting center was getting in its fine work.

The mode of procedure was this: The work was driven by a center, as shown in Fig. 3; the end to be turned was flattened slightly and the square center pushed up against it to somewhere near to the center. The tool post, with the aforesaid coaxer firmly fastened therein, was thus moved foward until it touched the handle, and the fun began.

The whole trick is simply to force against the revolving piece until the center is found by the square center, and this can be done very easily and quickly after a little practice.

You can force the work over until it is forced off the center, if you are not careful, and then there will be some tall dodging in your vicinity as the work goes off on an excursion around the room.

This method of centering is still largely used on brass castings, and I don't know as it can be much improved on for such work,

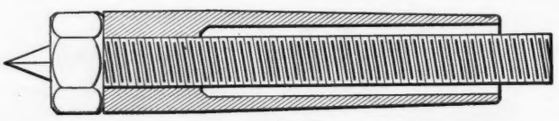


Fig. 5

which doesn't occur often in the ordinary shop. It is also used for finding the center of iron and steel bars, and these centers are then drilled and reamed according to the latter-day prophets. When a fellow has lent his center square to his neighbor and hasn't a centering machine, it isn't a bad way even now in the last lap of the nineteenth century. This isn't intended to advocate square centers for general use. The centering machine is the only civilized method for the shop that manufactures, but there is many a little shop with one man and two-thirds of a boy where the square center still has its place. FRED H. COLVIN.

The particular thing that called out the above letter was a sketch which was sent in showing an improved form of square center. It came from England and was contributed by James Vose in connection with his article in the last issue, but was held over until this number. The fact that the use of the square center is advocated by an Englishman, who is connected with a shop turning out work in considerable quantity, is an illustration of what is generally admitted by all; viz., that the English do not take up with "conveniences" in machine tools as readily as we do. This is not saying, however, that they do not get even with us in some other way.

THE IMPROVED CENTER.

The following is Mr. Vose's description of his improved center.

Square, or cutting centers are for various reasons more used in England than elsewhere for centering work, even where centering machines are in use. A very satisfactory design is shown in the accompanying sketch. The cutting part is of small diameter, screwed the whole length. This is threaded into the body of the center which is either mild steel, or the stump of an old center. A lock nut keeps the cutting part rigid. In the old style of solid square center the diameter was so large that the men shirked the labor of grinding it to gauge, and every time the center was hardened there was risk of cracking. In the present case, the cutter center being small, there is no trouble from these sources and it has the advantage that special centers can be made to interchange.

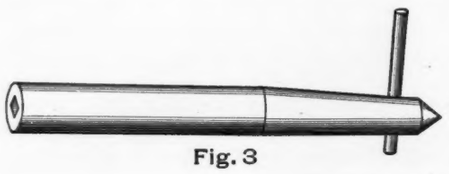


Fig. 3

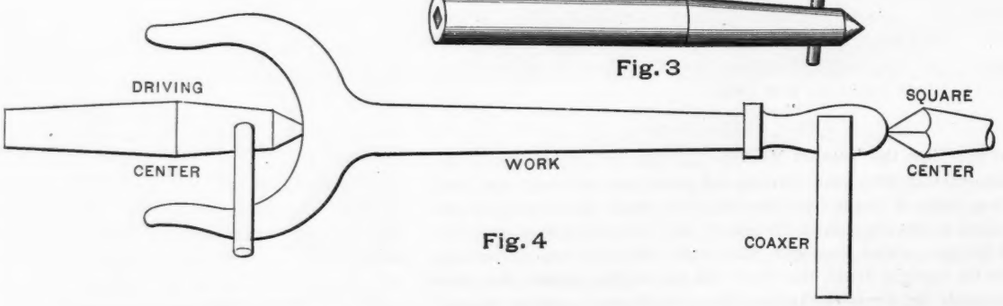


Fig. 4

* * *

THE Treasury Department publishes statistics showing that British vessels are carrying over 55 per cent. of the merchandise of the United States, both imports and exports.

HIGH SPEED BELTING.

M. E.

I take pleasure in replying to Mr. Grimshaw's remarks, which appeared in the July issue under the caption "Centrifugal Force of Belting," more especially so since I know from past experience that this much-esteemed contributor voices the difficulties of the majority of those who, for the first time, stop to consider the influence of this important factor in power transmission by belts and ropes.

In the first place, however, I should like to point out that Mr. Grimshaw has not read my contribution on "High Speed Belting" (March issue, p. 221), with as much care as might have been expected, and, as a consequence, he has credited me with statements which he will not find anywhere in my paper and which are, moreover, inaccurate and misleading.

Now, if Mr. Grimshaw will turn to my contribution again, he will find that *I never use the term "centrifugal force."* I employ "centrifugal *tension*," but this is not by any means synonymous with "centrifugal force," as a reference to any book on mechanics will prove. Unfortunately Mr. Grimshaw's failure to appreciate this difference has led him to make several misstatements which are certainly calculated to mislead users of high speed belting. The importance of the subject must be my excuse, if in my endeavor to set the matter straight, I may seem unduly prolix.

In Fig. 1 let A, C, B, 4, be a pulley rotating about the center *o*, which pulley, in order to simplify matters, we will take as being 16 feet in circumference. Dividing the right-hand semi-circumference into 8 equal parts, we obtain a series of arcs A 1, 1 2, 2 3, etc., each 1 foot in length. T A 4 B *t* is a belt running in contact with a pulley, as shown.

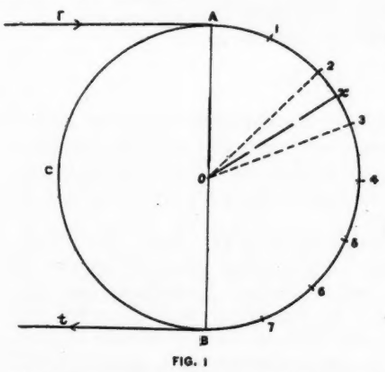


FIG. 1

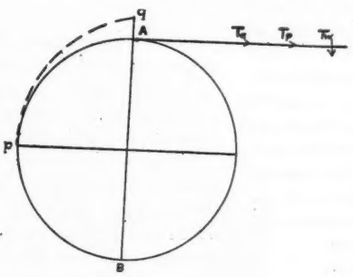


FIG. 2

Let us now consider a unit length of the belt, 23 for example, which is in contact with the pulley and examine the forces acting upon it. These are: A tension at 2; a tension at 3; and a radial force which we may take as acting along *ox*. If for the moment, we assume the unit length of belt, 2 3, to be isolated from the other portion and kept in contact with the pulley rim by means of a string *ox*, we know from elementary mechanical principles that the tension T_o induced in the latter is

$$T_o = \frac{w\,v^2}{32.2\,r}$$

in which w is the weight of the 1 foot section of the belt here considered; v the circumferential velocity of the pulley in feet per second and r the radius of the pulley, or length of string in feet.

Without entering into an unnecessary discussion of radial and tangential forces, it will be clear that this force is usually designated "centrifugal force," and further, that it increases directly as the weight w and inversely as the radius r, assuming the belt velocity to remain constant. Precisely the same reasoning may be adopted with regard to the other belt segments into which the arc of contact is assumed to be divided, and as a result we see that we have a set of conditions similar to those obtaining in a boiler shell, the stress at the points A and B is obtained by multiplying the pressure per inch by the *diameter* of the boiler A *o* B. Therefore, in precisely the same manner, we proceed to determine the tension in the belt at A and B by multiplying the pressure (or radial force) per inch (or per foot) by the diameter of the pulley A *o* B. We have, consequently,

$$T_c = \frac{w\,v^2}{32.2\,r} \times 2r = \frac{2\,w\,v^2}{32.2} \text{ or } \frac{w\,v^2}{3.22}$$

as the centrifugal tension induced in *each side* of the belt.

A consideration of the facts here presented will show that the *diameter of the pulley is entirely eliminated;* in other words, that the centrifugal tension in a belt is absolutely independent of the diameter of the pulley on which it runs, so long as its lineal velocity is constant. From this Mr. Grimshaw will see that his table of comparative "centrifugal force" is quite useless in this connection; while his suggestion that "the advantages of high belt speed, got by increased pulley diameter, are apparent in the decreased centrifugal force," is also wrong. It is, of course, true, that considering each unit length of belting, the *centrifugal force* will be halved if the pulley diameter be doubled, but the fact must not be overlooked that in the latter case, there must of necessity be twice the weight in motion since the length of belt in contact with the pulley is increased in like ratio.

But apart from this, Mr. Grimshaw's efforts have been directed towards the determination of the centrifugal force of a unit length of belt—a result which, even if correctly calculated, would have been useless in the present instance. Reverting to our boiler analogy, such an expression will be seen to be equal to giving the pressure per square inch in a boiler, as the tension tending to produce rupture at A and B (Fig. 1). This is, of course, meaningless. It is (in Fig. 1) the horizontal component of the resultant of the sum of the pressure acting upon every inch of the semi-circumference—of the boiler shell in that one case, and of the pulley rim in the other—that represents the tensions with which we are concerned. If any further confirmation is needed, I would point out that Mr. Grimshaw uses a strip of belt 1 inch wide and 1 inch long, in his example; but there is no reason why a length of 6 inches or 12 inches or ½ inch, should not be used, in which case different results would have been obtained every time. But when the *resultant* effect is taken, it is immaterial what units are used as the ultimate results cannot differ.

Doubtless by this time Mr. Grimshaw will have discovered one very egregious error he has made in modifying the formula given in the foot-note on page 349. It will be seen that in order to use the pulley radius in *inches* he has *divided* the denominator by 12 instead of *multiplying* it by 12. The result is of course that the value he obtains is *144 times too large.* Correcting this, we find that the centrifugal force of each 1 inch length of belt is 2.158 pounds, instead of 311.5 pounds as stated. As I have explained in the foregoing, to obtain a tangible result from this, it is necessary to multiply by the pulley diameter—taking this in inches—if inch units are used, or in feet if, as is more usual, foot lengths of belting are taken. We have, therefore, $2.158 \times 28 = 60.4$ pounds as the total centrifugal tension per inch of width, or 30.2 pounds on each side of the belt. It is readily seen that the more simple formula

$$T_c = \frac{w\,v^2}{3.22}$$

gives precisely the same result, for here $w = .0059 \times 12 = .0708$ and $v = 117.2$ feet per second. Then we have—

$$\frac{.0708 \times 117.2 \times 117.2}{32.2} = 30.2 \text{ pounds as the tension in each side}$$

of the belt as before.

Having explained the method of computing centrifugal tension in a belt, I will take Mr. Grimshaw's objections seriatim, as these embody several erroneous notions on the subject, which I have repeatedly found are held by many practical men.

Dealing first with the india-rubber rim, I would say that if there is any "fun" in this suggestion, it lies in the fact that your contributor has herein supplied an excellent argument against himself. He admits that the rubber rim would stretch and become generally larger, a result plainly brought about by the existence of a *tension* in every part of the rim, and which is induced by centrifugal action. As for the position which the rim would take up, this does not appear to me to be at all difficult to comprehend. The rim will expand until the resultant speed, after allowing for slipping, is such that the centrifugal tension induced is just sufficient to keep the rim up to its expanded diameter. Any increase of speed would lead to an increase in diameter and increased slip, but there would be a position of equilibrium for each velocity just as in the case of a steam engine governor.

In the next paragraph Mr. Grimshaw makes some exceedingly curious assertions, but most, if not all, of the mistaken views he holds are traceable to his failure to distinguish between *centrifugal force* and *centrifugal tension*. If the former could exist in a belt, without the latter, there might be some ground for anticipating that a belt would perform such gymnastic evolutions as suggested. But I trust that in the light of what I have written above, the absurdity of the suggestion will readily become manifest. I would point out, however, that while careful to insist upon the tendency of particles rotating in a circular path to leave that path in a *tangential direction*, he finds it convenient to deny this privilege to the belt in his Fig. 4. This is, to say the least, somewhat inconsistent.

Referring to the cut just mentioned, it appears to me that your contributor imagines that a belt particle at p, Fig. 2, would, under the action of centrifugal force, move in the direction $p\ v$. But there are at least two factors which operate against this tendency, (1) the centrifugal tension T^c, (2) the tension T_P due to the power being transmitted; while on the upper side of a horizontal belt there is also (3) the weight T of the belt. If, now, Mr. Grimshaw will again consider the matter, he will see that there is no reason why the contour of a belt drive should be materially different at high and low speeds. Of course his Fig. 5 represents an improbable state of affairs, which I will not consider.

The next paragraph, referring to the speed of rotation of mill spindles, contains another illustration of the actual point at issue. With 1½ inch diameter pulleys, 13 000 revolutions per minute means a belt speed of 5 100 feet per minute only, and with the light belts used in this service, it is readily seen that the resulting centrifugal tension would not be great.

As to the 30 000 revolutions made by a small emery wheel—this with a 1-inch pulley would mean a belt speed of about 7 850 feet per minute, or 131 feet per second. Taking the weight of a light belt 1 inch wide, at .06 pound per lineal foot, we find the centrifugal tension represents a stress of 27 pounds per inch of width, so there is not much "misfit" about this application of the formula, after all. The other remarks as to saw-mill pulleys are all taken care of in the foregoing. So far as this aspect of the question is concerned, there is, as I have shown, nothing in Mr. Grimshaw's theory as to the advisability of using large pulleys. Rather is the reverse the case, since with the same ratio of pulleys the belt speed and consequently the centrifugal tension, would be greater. Other advantages accrue, however, from the use of large pulleys, which may far outweigh the objections herein referred to. But this, of course, is another story.

* * *

SPUR GEAR ARITHMETIC.—3.

ARTHUR B. BABBITT.

DEPTH OF TOOTH.

After we get the gear blank turned up, we next want to know how deep to run the gear cutter in order to get a perfect tooth. The working depth of the tooth we have shown to be equal to the sum of the addendum and dedendum or $\frac{1}{P}+\frac{1}{P}=\frac{2}{P}$ and the whole depth of the tooth must equal $\frac{2}{P}$ plus the clearance.

Using the Brown & Sharpe standard, we have $\frac{2}{P}+\frac{.157}{P}=$

$$E=\frac{2.157}{P} \quad (10)$$

in which E = full depth of tooth.
P = diametral pitch.

Example: Given a gear of 6 diametral pitch, to find the depth of cut to be taken to get a perfect gear tooth.

Divide 2.157 by 6 (diametral pitch) and the quotient .359 is the depth to be cut in the gear.

If we had the circular pitch given to find the depth of tooth, we could substitute in formula (10) the value of "P" as given in formula (2) and we would have

$$E=\frac{2.157}{\frac{3.1416}{P^1}}$$

which, reduced to its simplest form, is:

$$E=\frac{.6866}{P^1} \quad (11)$$

in which E = depth to be cut in gear.
P^1 = circular pitch.

Example: Given a gear 1½ inches circular pitch to find the depth to be cut.

Divide .6866 by 1½ (circular pitch) and the quotient .457 is the depth to be cut in gear.

Following is a table giving the depth to be cut in a gear for the different diametral pitches:

TABLE NO. 4.

Diametral Pitch.	Depth to be cut in gear.	Diametral Pitch.	Depth to be cut in gear.
2	1.078 inches.	12	.180 inches.
2¼	.958 "	14	.154 "
2½	.863 "	16	.135 "
2¾	.784 "	18	.120 "
3	.719 "	20	.108 "
3½	.616 "	22	.098 "
4	.539 "	24	.090 "
5	.431 "	26	.083 "
6	.359 "	28	.077 "
7	.308 "	30	.072 "
8	.270 "	32	.067 "
9	.240 "	36	.060 "
10	.216 "	40	.054 "
11	.196 "	48	.045 "

DISTANCE BETWEEN CENTERS.

Having given the number of teeth and diametral pitch of two gears, to find the distance between centers. Add the number of teeth together and divide by twice the diametral pitch, or

$$\frac{N+n}{2P}=C \quad (12)$$

in which N = number of teeth in one gear.
n = number of teeth in other gear.
P = diametral pitch.
C = distance between centers.

This formula is obtained from formula (3):

$$\frac{N}{P}=D.$$

This formula gives us the pitch diameter of a gear, and, if we get the pitch diameters of two gears and add them together, we have twice the distance between centers, for the sum of the pitch diameters is twice the sum of the pitch radii, which is the distance between centers.

We have now traced, by the aid of a few "rules," the proportions of a gear tooth, having given the pitch and number of teeth through pitch diameter, addendum, dedendum, clearance, width of tooth and depth to be cut, up to the distance between centers. We now give some formulæ for the solution of problems in which are some of the quantities which were known in preceding problems, but are liable to be unknown.

PITCH.

1st. To find the pitch, having given the pitch diameter and number of teeth. Divide the number of teeth by the pitch diamter, and the quotient will be the pitch. The proof of this assertion is derived from formula

$$D=\frac{N}{P} \quad (3)$$

If the pitch diameter equals the number of teeth divided by the pitch, then the pitch diameter multiplied by the pitch must equal the number of teeth; therefore the pitch must equal the number of teeth divided by the pitch diameter, and this, expressed in its simplest form, is:

$$P=\frac{N}{D} \quad (13)$$

in which P = pitch (diametral).
N = number of teeth in gear.
D = pitch diameter.

Example: A gear 3 inches pitch diameter has 36 teeth. Find the diametral pitch.

Divide 36 (the number of teeth) by 3 (the pitch diameter), and we have 12, the diametral pitch of the gear.

2d. Having given the outside diameter and number of teeth, to find the diametral pitch. Add 2 to the number of teeth and divide by the outside diameter and the quotient will be the pitch of the gear.

In formula (5) we have:

$$\frac{N+2}{P}=D^1 \quad (5)$$

if the number of teeth + 2 divided by the pitch equals the outside diameter, then the outside diameter multiplied by the pitch must equal the number of teeth + 2, and then the pitch must equal the number of teeth + 2 divided by the outside diameter, which, expressed as a formula, is:

$$\frac{N + 2}{D^1} = P \quad (14)$$

in which N = number of teeth in gear.

D^1 = outside diameter.

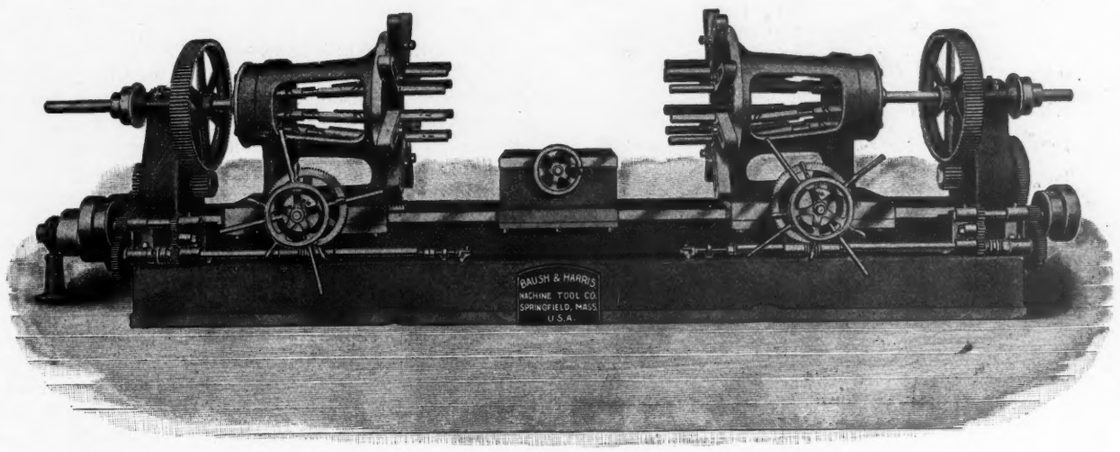
P = diametral pitch.

Example: Given a gear of 36 teeth and $3\frac{1}{8}$ inch outside diameter to find the diametral pitch.

36 (the number of teeth) + 2 = 38

38 ÷ $3\frac{1}{8}$ (outside diameter = 12, the diametral pitch of the gear.

WHEN people get educated up to the idea that expert service is required in mechanical work, just as it is in law or medicine, there will be some hope of diminishing the number of cases where engines run away and wreck themselves and everything about them. Any steam user can do two things which will at least have a tendency to make him secure against such accidents. When purchasing an engine he can put the matter in the hands of a competent mechanical engineer, who will see to it that the design and specifications are what they ought to be; and second, he can hire a competent engineer to operate the plant and pay him accordingly. These methods, we believe, are being adopted more than formerly, especially where large plants are concerned; but, how about the smaller ones? Men are bound to make mistakes, the best of them, and as long as men design, make and operate engines, fly-wheels will continue to burst.



MULTIPLE SPINDLE DRILL.

A NEW MULTIPLE SPINDLE DRILL.

The horizontal, double-head, eight spindle drill shown in the accompanying illustration has recently been brought out by the Baush & Harris Machine Tool Company, of Springfield, Mass.

It embodies in its construction the general features of the regular vertical machine built by the same company, but has been modified in several respects to better adapt it to automatic and jig work, thereby producing a very economical tool for all kinds of general drilling within its capacity.

The machine is capable of saving a great amount of labor where a number of holes are to be drilled in one piece, as in cylinder ends, pipe flanges, valves, etc. Any number of holes up to 16 can be drilled at once in the time otherwise necessary for drilling one.

A feature of the machine is its adaptability to any layout of holes. For example, it can be set to drill eight holes, or less, in a straight line, a square, an oval, or any other layout that will come within an 18-inch circle, which is the largest drilling circle that can be used with this size machine. Another feature is the automatic quick return of the heads by power after the holes have been drilled. Holes up to one inch in diameter can be drilled and the length of the spindles can be changed to suit different lengths of twist drills.

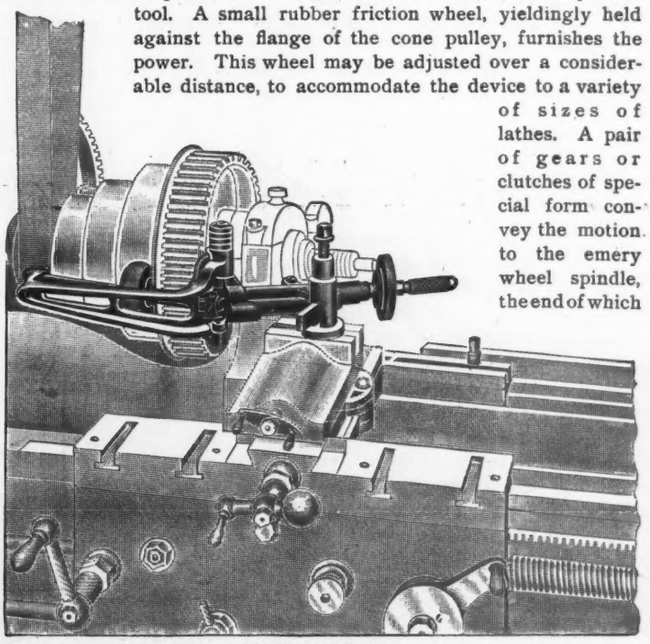
Referring to the illustration, the cone at the left drives a shaft which passes along the back side of the bed, and to each end of which are attached gears, suitably arranged for driving each head. The gearing for the feeds and reversing mechanisms is shown in front at each end of the bed, and is independent for each head. It can be operated either by hand or automatically through rods connecting with the heads and having adjustable collars, which engage with a stop at the side near the center. This gearing is proportioned to give a quick return of head equal to five times the feed.

The machine illustrated was used for drilling the ends of steam cylinders, jigs being used that were arranged to back away from the work, allowing the cylinders to be removed or placed in position without taking the jigs from the table. Any desired length of bed can be supplied.

CENTER GRINDER.

The above illustration shows the new Stewart Centre Grinder, now being offered to the trade by the Chicago Flexible Shaft Co., 158–160 Huron street, Chicago, Ill.

As will be seen by referring to the cut, the device is very simple. It is set in position in the same manner as an ordinary lathe tool. A small rubber friction wheel, yieldingly held against the flange of the cone pulley, furnishes the power. This wheel may be adjusted over a considerable distance, to accommodate the device to a variety of sizes of lathes. A pair of gears or clutches of special form convey the motion to the emery wheel spindle, the end of which is provided with a knurled fibre sleeve with which the wheel may be moved back and forth, as the operation of grinding may require.



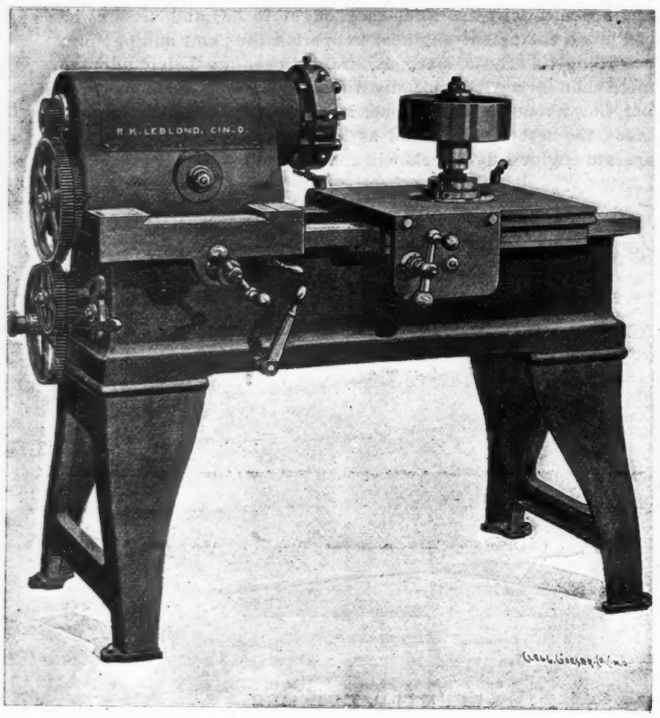
CENTER GRINDER.

* * *

Any readers of MACHINERY who do not intend keeping a file of their papers will confer a favor on this office by mailing us the number for October, 1896.

PULLEY MILLING MACHINES.

The machine illustrated herewith will attract the attention of mechanics, from the fact that it does, in an unusual way, one of the most common operations met with in a machine shop. It is designed for milling the faces of pulleys parallel with the bore, and will take pulleys up to 36" diameter and 8" face. The carriage has a movement of 16 inches on the shears and can be



MACHINE FOR MILLING PULLEYS.

clamped rigidly in any position. It carries a sleeve that is driven by a large worm and worm-wheel through feed gears, which latter can be varied to suit the size of the pulley. Fitted in this sleeve is a spindle with a taper hole to fit different arbors for different sized pulleys.

The main spindle is made of the best crucible steel and is driven by a worm and worm-wheel at a ratio of 1 to 36. The worm is driven by a 3 step cone pulley and has ball-bearing thrust collars, and both the worm and thrust collars run in oil. The front bearing of the spindle is 4 inches in diameter and is so tapered that it can be readily adjusted to take out all play. The nose is threaded for cutters.

The crowning of the pulleys is effected by setting the head to one side of the center, the amount ot the crown depending upon the relative position of the cutter head and the pulley arbor. If the head is set so that the cutters run in line with the center of the pulley arbor the face will be practically straight, but if the head is brought forward and set so that the cutters touch the pulley 2 or 3 inches ahead of the center, it will produce a very marked crown. To produce equal crowning on each side of the pulley, it is necessary to set the center line of the latter in line with the cutter spindle, in a vertical direction, and provision is made for doing this.

In milling a lot of pulleys it is found that the most economical method is to rough them out first with one cutter head and then finish with a second cutter head, the pulleys being set to a stop in both operations, which makes all of them come exactly alike.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

For the best practical idea sent us each month to use in this column we will send a copy of Usher's "Modern Machinist," or Grimshaw's "Shop Kinks." For the next best we will enter a subscription for one year to MACHINERY to any desired address. For the next best, or for any idea that is worth publishing, we will send a copy of Colvin and Cheney's "Machine Shop Arithmetic."

The first installment of ideas sent in competition for these prizes is published in this issue. The winners of the first and second prizes will be announced in the November number.

LOOKING FOR A LEAK—HARDENING CAST IRON.

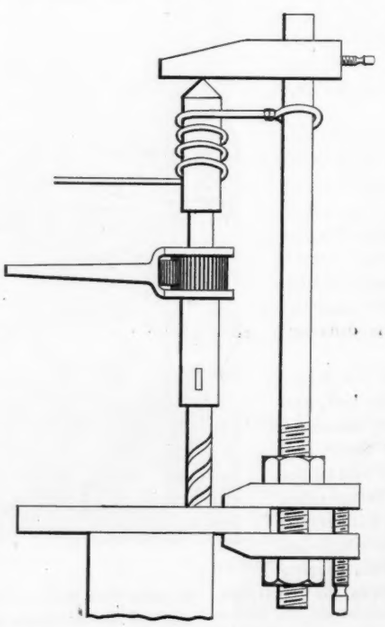
John Lookaback's "Biggest Pump in the City" reminds me of an experience in Chicago. There was a large tank just under the roof, and the tank was practically the top of a stand-pipe from which water was used on the different floors; I don't know why it was made this way, but so it was. As luck would have it, the height of the building and the nominal city pressure were relatively such that when the city pressure was "up" the tank would just keep full. I presume that the genius who designed the affair thought that the big tank at the top would give him more pressure in his stand-pipe, but as said above, I don't know anything about this point. What I do know is that during the day time when all the factories were drawing water, the pressure would run down so that the "engineer" would need to help out with his pump to supply water to the top floors, because the city pressure wouldn't take the water up there. When the place was shut down at night the tank would be full, and the city pressure would keep it so until about 6 o'clock in the morning, when everybody began to draw water again, so by the time the "engineer" got around to look in the tank, it would be empty; in consequence of which the engineer spent all his spare time *looking for that leak*.

Concerning the hardening of cast iron pieces, which J. E. G. asked about in the last number, I have seen small cast iron pieces in a sewing machine factory successfully *case hardened*; the process being just the same as for wrought iron or soft steel pieces.

W. L. C.

A FRICTION RATCHET FEED.

The following sketch shows how some of the men in the shop save the wear and tear on their hands incident to feeding by hand, and at the same time secure a much steadier feed. A light pull on the cord gives a constant and even feed.



W.

COPYING OUTRIGHT.

MR. EDITOR: I confess to being stupid enough not to see the implied semi-criminality in "copying outright," to which you refer editorially in the September issue. Both England and the United States have patent laws mutually available to citizens of both countries, and it seems to me that when a designer, or a manufacturer, does not make use of his privileges in this respect he has no reason to complain, or at least no cause for serious grumbling.

The fact that some one in England has copied the Hendey Machine Co.'s shaper shows that he knows a good thing when he sees it, and it is a good advertisement for the company. Incidentally it advertises the copyist's good judgment. Of course he labors under the disadvantage that is so well known, viz.: that a copy seldom equals the original, which is his misfortune but not his crime.

The British manufacturer has, as a matter of record, in years gone by, put a good deal more metal into his machine tools than his American competitor, and the latter has gone a good deal further in the way of handiness. Of late the British tool builder has made creditable advances in copying

American conveniences, and the American builder has gone about the same distance in copying British solidity. Each has been wise in his way.

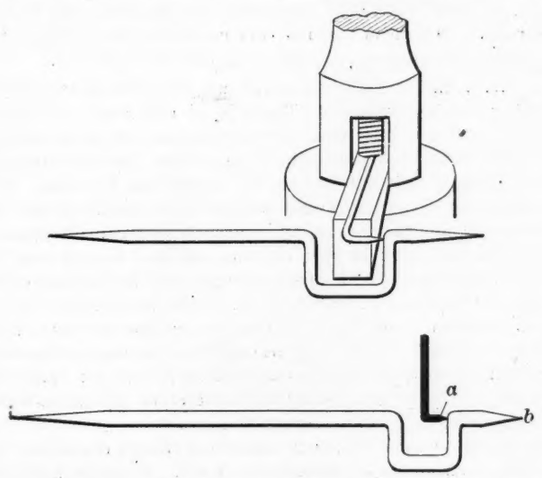
When it comes to copying rather literally, if my neighbor on this or the other side of the water builds a machine exactly suited to requirements, and puts up no legal bars to prevent me from following his lines, I see no reason why I should either add some abominable superfluity, or cut off some necessity, to avoid "copying outright." If there is any difference it seems to me rather more manly to "follow copy," thereby acknowledging that I cannot improve it.

I am aware that the plan I am upholding is not the popular plan, but I submit that there are always two sides to a question. There isn't any moral or any other reason why I shall not copy my neighbor in getting up at five o'clock in the morning, though by doing so I distance him in business. G. F.

A CHEAP AND SIMPLE CENTER INDICATOR.

The other day, in the shop, a jig was being made which needed to be accurate. No indicator was to be obtained, but in five minutes one was made which answered so well that it has been used ever since. For centering prick-punch centers on the face-plate it serves every purpose.

A ⅛-inch soft steel wire was quickly bent in the vice like the accompanying sketch. At the point (*a*) a prick-punch mark was made. Both short and long ends were quickly tapered on the emery wheel to a fine point. A lighter wire of spring steel bent into the shape of a letter L, and also pointed, completed the out-



fit. With the second wire held in the tool-post on top of a reversed tool, and the end (*b*) on the point to be centered, just the right tension to hold the indicator was obtained by moving the carriage. The heavy U-shaped loop in the indicator holds the tool in a stationary position, no matter which way the lathe spindle revolves. R.

SOLUTION TO MR. ROGERS' PROBLEM.

In answer to the problem by Mr. Rogers on page 30 of the September issue.

$\frac{96 \div 2}{24} = 2$. $2 \times \frac{1}{8}$ inch $= \frac{1}{4}$ inch; therefore a 4-pitch thread will be cut when C is in mesh with A. $2\frac{1}{4}$ inch $\div \frac{1}{4}$ inch $= 9$; the ratio of the back gears is 9 to 1.

For the benefit of some of the apprentices who may not be able to see through my solution clearly, I will add the following detailed explanation:

Mr. Rogers does not state which of the two gears (A or B) C is in mesh with when stud D makes one revolution to two of spindle, but the problem and sketch show clearly that he must mean that D makes one revolution to two of spindle when C is in mesh with A.

Now if D has 96 teeth and only makes one revolution while A makes two, one revolution of A is equal to one-half of a revolution of D; or, one-half of 96 teeth, which is 48 teeth, and 48 teeth is exactly twice as many as there are in the gear on the lead screw driven by D. Consequently one-half of a revolution of D will cause the lead screw to make exactly two revolutions. The lead screw being 8 pitch, there is one thread on it for every ⅛ of an inch in length, so two revolutions of it will advance the carriage ¼ of an inch, or 4 pitch, while the spindle makes one revolution. With the gear C in mesh with B it is stated that a screw of $2\frac{1}{4}$ pitch can be cut, so when C is driven from B the carriage must advance $2\frac{1}{4}$ inches to each revolution of spindle, and $2\frac{1}{4}$ is just 9 times as much as ¼, showing that C is driven 9 times faster by B than by A, which has the same number of teeth; consequently B must run nine times as fast as A, or a ratio of 9 to 1. MILO.

[We also received solutions from "E. H. O.," who neglected to send his name and address, and from Mr. John T. Giddings, Providence, R. I.—ED.]

A RUSH JOB.

"Sam, there is a ⅝ hollow mill that Joe just turned up. Take it down stairs and get it milled at once, the screw machine is waiting for it." And the foreman's tone indicated that no delay would be allowed. Finding the milling machine in a cut such that it was impossible to stop for some time, the foreman was looked for, but, as is often the case when in a hurry, he was in the office in consultation.

Now that mill was wanted "bad," so here is the way we got it out and got it all done before the milling machine was ready to take hold of it.

We took a piece of ⅝ inch square steel, four inches long, turned the end so it would drive into the plug end of the hollow mill, leaving about two inches of steel still square, as shown in Fig. 1.

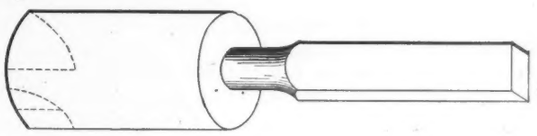


FIG. 1.

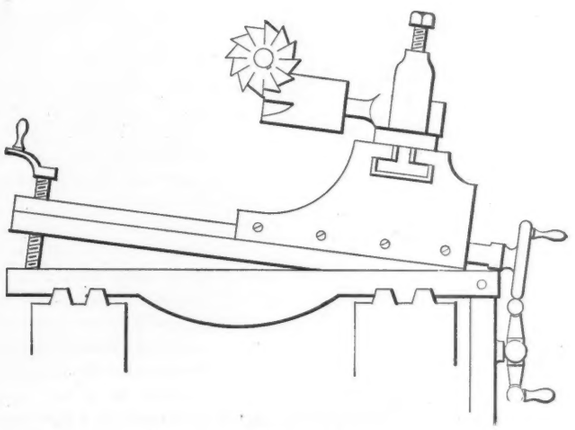


FIG. 2.

The square piece of steel, with the hollow mill on the end, was put in the tool-post of a lathe, as if it were a turning tool, as indicated in Fig. 2. The lathe had a rise and fall carriage, so we were able to adjust the blank to any desired position. The feed was by means of the cross-feed screw.

The arbor which carried the milling cutter was placed between the lathe centers and driven by the usual dog. After one cut was made the screw in the tool-post was loosened and the blank given a quarter turn, which brought another face of the square down and so accurately spaced the next tooth, and so on.

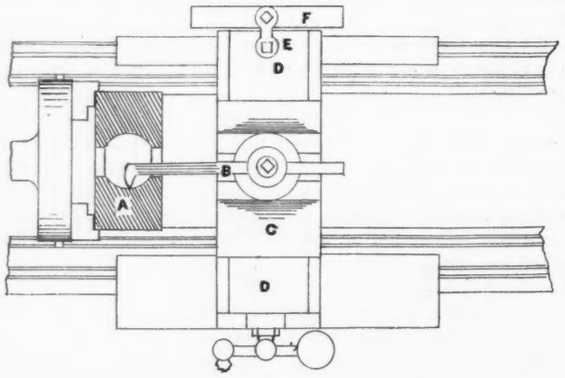
That this is a practical method will be seen in the fact that a certain tool manufacturer, who sold these hollow mills to various tool dealers, made them in this way for several years before he owned a milling machine. This method has a variety of other applications, also. SOME WAY.

SPHERICAL BORING RIG.

The sketch shows a spherical boring attachment which is readily applied to any engine lathe having the Slate taper device, or not so readily to one having the ordinary compound rest.

In the sketch A is the work to be bored in the chuck, B is an ordinary boring tool with a V point, held in the tool-post as usual; D is the independent slide which is controlled by the taper bar at the back of lathe. In this case the bar is removed and a short link E substituted, working freely on screws in D and the stationary part F. The link is made so that the distance between centers is equal to radius of hole to be bored.

As the carriage feeds towards the headstock, the point of the tool is bound to follow the arc of a circle, being governed by the link, as the outer end is stationary.

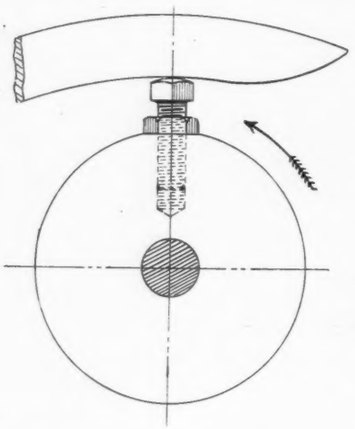


A hole bored by this arrangement is not strictly spherical, as the width of the point of the tool is added to the longitudinal diameter; but by a little management this error can be reduced to a minimum.

FRED E. ROGERS.

AN ADJUSTABLE CAM.

The writer was recently employed by the —— Mfg. Co. to do some missionary work on one of their machines, and among other items of novelty supposed to be useful in rotation was this adjustable cam. It appeared to be about the worst makeshift for a cam that we have seen of late; especially so in consideration that it was found that in practice this cam lift, when once established, needed no further adjustment; and some of the mechanicalists (supposed to be wise ones whom the president sometimes took into his council chamber) expressed themselves that this cam was a valuable feature on the machine. Suffice it to say that the writer was not long in expressing his preference to a hardened roll as better than the head end of an ordinary set screw. This object lesson in cam-ology may prove a lesson with a moral: don't try to make a cam out of a set screw and jam nut.



F. W. CLOUGH.

* * *

WEIGHTS OF BEAMS, SHAFTING, ETC.

The following, taken from *A Text Book on the Mechanics of Materials*, by Mansfield Merriman, is very convenient to remember in computing the weights of bars, beams, shafting and pieces of uniform cross-section:

A wrought iron bar one square inch in section and one yard long weighs ten pounds.

Steel is about two per cent. heavier than wrought iron.

Cast iron is about six per cent. lighter than wrought iron.

Timber is about one-twelfth the weight of wrought iron.

For example, consider a bar of wrought iron $1\frac{1}{2} \times 3$ inches and 12 feet long; its cross section is 4.5 square inches, hence its weight is $45 \times 4 = 180$ pounds. A steel bar of the same dimensions will weigh $180 + 0.02 \times 180 =$ about 184 pounds, and a cast iron bar will weigh $180 - 0.06 \times 180 =$ about 169 pounds.

By reversing the above rules the cross-section of bars are readily computed from their weights per yard. Thus, if a stick of timber 15 feet long weighs 120 pounds, its weight per yard is 24 pounds, and its cross-section is $12 \times 24 =$ about 28.8 square inches.

* * *

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HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

8. "Ignorant" writes: I wish to arrange a lathe for turning wood, having a head and tail stock 12" swing. What should be the slowest and fastest speeds for turning pieces from 12" to 1" diameter. In other words, what is the proper surface speed for wood turning? *A* Wood may be satistactorily turned at a surface speed of 5 000 to 8 000 feet per minute, some say 10 000, according to the kind of wood. But for small work it is not generally practicable to approximate this speed very closely. If everything is nicely balanced and journals and bearings in good condition, you might probably average for slowest speed 600 revolutions; fastest 6 000, the slowest being for roughing out.

9. J. T. S. asks: How many flutes or grooves shall I mill in a hob for cutting a worm wheel, the hob being $6\frac{5}{16}$ inches diameter and $1\frac{1}{4}$ inches pitch? *A*. The Brown and Sharpe Mfg. Co. from whose work, "Practical Treatise on gearing," we quote by permission, say—"The thickness of cutter for grooving hob can be about one-half the width of thread at top plus $\frac{1}{8}$ inch. The width of lands at the bottom can be about the depth of thread plus $\frac{1}{8}$ inch. The grooves are usually cut with a round edge cutter, the parallel front of the cutter just reaching the bottom of thread." There is nothing very particular about this. We should make the cutter $\frac{7}{16}$ inches thick and cut 8 grooves.

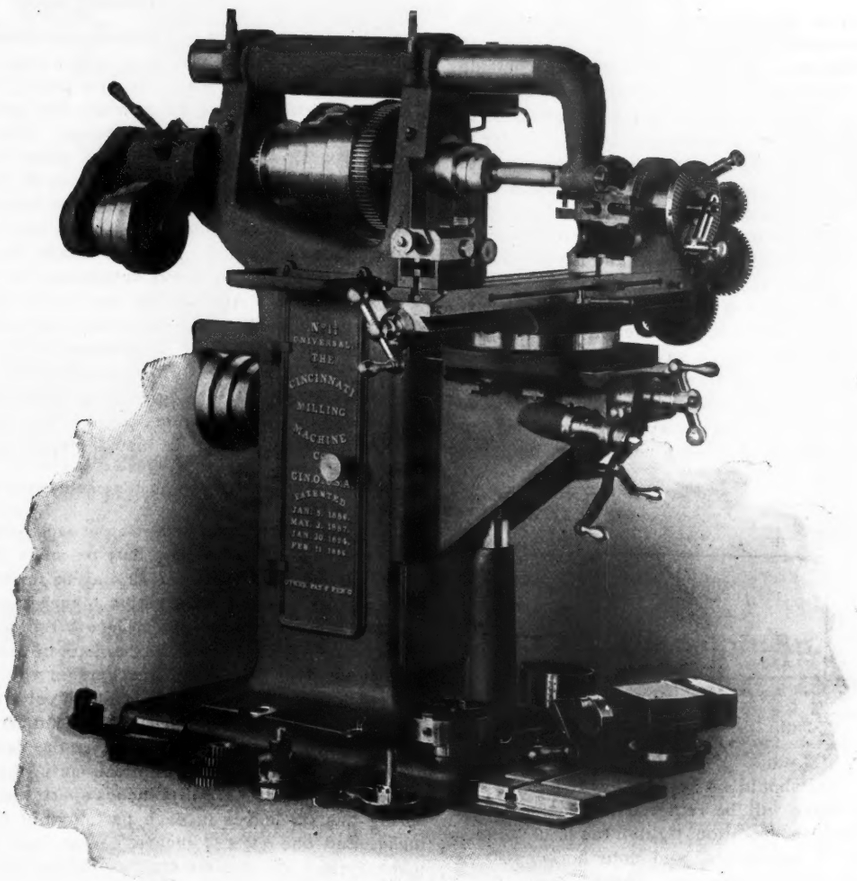
10. W. N. B. asks: 1. Please give rule for width and thickness of spring packing rings. *A*. There is no rule used in practice for either width or thickness. In general they are made from $\frac{3}{8}$ inch wide for small pistons to $\frac{1}{4}$ for large ones, the most common width being $\frac{1}{2}$ inch for any piston larger than 8 inches. The thickness will vary from $\frac{3}{32}$ inch for small pistons to $\frac{1}{2}$ inch for large ones, the thickness being governed by a consideration of being able to spring or open the ring sufficient to pass over the body of the piston. 2. How much larger than the bore of cylinder should the rings be turned? *A*. For small pistons of 3 or 4 inches diameter, they may be $\frac{1}{8}$ inch larger than the bore of the cylinder, advancing the size $\frac{1}{32}$ for each inch increase in diameter of piston up to 9 inches, then advancing $\frac{1}{64}$ inch for each inch increase. 3. What is the limit in diameter of piston on which springs can be used? *A*. There is no limit.

The second volume of Unwin's Machine Design contains a full theoretical discussion of the above subject. It can be had from Longmans, Green & Co., New York, for $1.25.

11. J. D. asks: Please give me the solution of 3.1416 through your columns. *A*. The number 3.1416 is the length of the circumference of a circle whose diameter is 1. That is, the circumference of a circle one inch in diameter is 3.1416 inches; of one foot in diameter, 3.1416 feet; of three feet in diameter, $3 \times 3.1416 = 9.4248$ feet, and so on. The proof of the foregoing depends upon one of the most advanced demonstrations in plane geometry and therefore cannot be understood without a fair knowledge of that study. It can be proved by geometry that if a polygon having 2048 equal sides, should be drawn inside of a circle one foot in diameter, the total lengths of its sides would be 3.141588 feet; and if another one of the same number of sides should be drawn outside of the circle the total length would be 3.141592 feet. The mean of the two would therefore be the approximate length of the circumference, or 3.14159 feet. This number is always represented by the Greek letter π (pronounced pi) and carried out to more places of decimals is 3.14159265359. Four places of decimals, or 3.1416, is sufficiently accurate for most purposes.

12. F. B. writes: 1. Wish to know if repairs can be done to the wires of lamps connected with a fuse wire to the main wire. By turning these six lamps out can repairs be done to either lamps or wires without switching off the current? *A*. Incandescent lamps, and the wires connecting them with the main circuit, can be repaired by simply disconnecting, or turning off the lamps, but it is not an advisible course to pursue, unless the operator is well enough versed in electrical matters to guard against bringing the positive and negative ends of the wire in contact. If such contacts are made, the result will be that there will be a rush of current great enough to fuse the wires at the points of contact, and possibly damage them so much as to require their

A modern Tool-room Machine.



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Power cross and longitudinal feeds.
Sixteen spindle speeds and twelve feed changes.
Quick return to the table.
Independent handles for all adjustments.
Circular swivel carriage with positive clamping facilities.
High grade workmanship and materials.

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The Cincinnati Milling Machine Co.,
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renewal. The safest plan is to open the circuit, either by removing the fuse or turning a switch, if there is one, and no other course should be pursued if the lamps are fed from an "arc," or railway circuit. 2. How many lamps constitute one HP.? *A.* Sixteen candle lamps absorb from one-twelfth to one-fifteenth of a HP, but as energy is required to transmit the current through the wires, from the generator to the lamps, and as there is a loss in transforming the power of the steam engine, or water-wheel, into electricity, the actual amount of power required to keep the lights in operation varies from one HP. to ten lamps, to one HP. to twelve lamps.

13. G. R. T. writes: In what way other than by the use of the indicator, can I determine the power of small engines, from 1 to 5 HP. What I want to find is the power of the engine outside its own friction? *A.* Some modification of the Prony brake is very commonly used for this purpose. By particular attention to construction and by providing for the free circulation of water to keep the parts in friction cool, engines are tested by this brake to as high as 100 HP. For engines from 1 to 5 HP. some such simple arrangement as is represented in Fig. 1 may be employed. The friction is increased or decreased by tightening or loosening the nuts on the wooden friction blocks *a*, *a*, and is recorded on the platform scale. A plate on the wooden arm A rests on the small roller *c*, which is journalled in the top of column B, the base of which rests on the scale platform. The height of column B, which may be made of four boards sawed taper and nailed together, should be such that a line drawn from the upper surface of roller *c* through center of shaft will be horizontal, that is, at right angles to a plumb line. The pulley represented may be either the balance-wheel pulley of the engine, or a special pulley

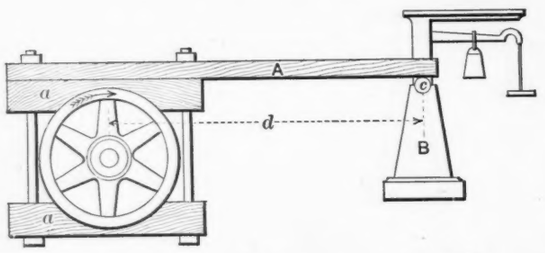


FIG. 1.

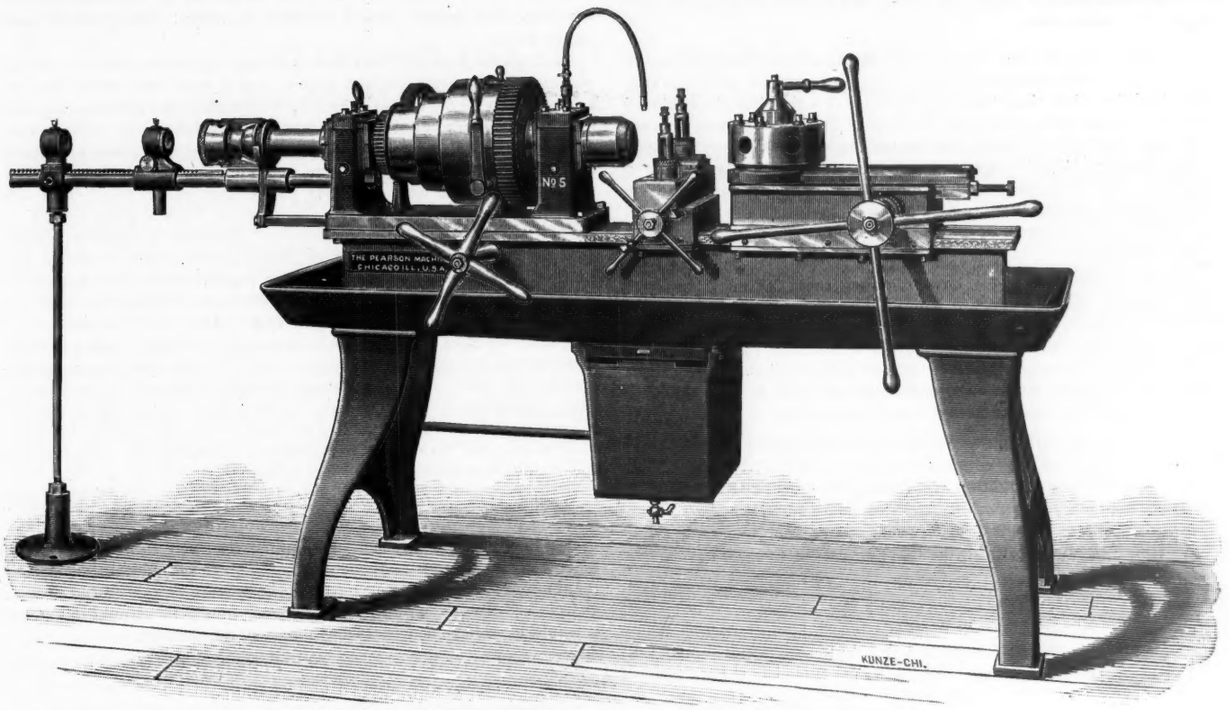
placed on the shaft. Oil should be applied to the friction surfaces, and generally water will be required for cooling these parts. The engine being in operation, tighten the brake so long as satisfactory speed is maintained, and note how much the weight indicated by the scale is increased. The column will have some weight and the unbalanced weight of arm A will be something. To ascertain what the sum of these will be, loosen the nuts till the friction blocks are quite free, (the engine being at rest) and note the weight indicated. This must be deducted from the weight indicated when the engine is in motion and the blocks tightened. The question is now one of foot-pounds, or horse-power. To calculate this we must know the weight indicated by the scale less the weight of the parts previously referred to, the horizontal distance from the center of shaft to the center of roll—the distance *d*—and the number of revolutions made by the engine. The weight found, as indicated above, may be considered as pressure acting through space represented by the circumference of a circle the radius of which is the horizontal distance from center of shaft to center of roll; say this distance is 30 inches (2.5 feet). The diameter is 5 feet and the circumference $5 \times 3.1416 = 15.7$ feet. The revolutions are 300 per minute; the scale indicates that 30 pounds are due to the engine being in motion. The HP. is $\frac{15.7 \times 300 \times 30}{33\,000} = 4.28$. In adjusting the scale and column, pains should be taken that the center of pin *c* will be exactly some known distance—in this instance 30 inches—horizontally, from the center of shaft, and both scale and column should be chocked against moving. Some means should be taken to prevent the friction blocks from working off the pulley. For this purpose two or more clips may be fastened to the blocks, extending up past the rim of pulley. Other means than the one indicated may be taken to bring a correct bearing between the end of arm A and column B, such as to make the column a few inches shorter and put an iron plate on top of it, then use an iron rod of suitable length, pointed at the ends, to engage suitably located prick punch marks in this plate and the plate on arm A. Or a spring balance may be inserted in a cord extending from arm A to the floor, or some point below it; or weights may be suspended from A. If either of the last two named plans is employed the motion of wheel in relation to position of arm A will be in an opposite direction from that indicated. The opposite end of arm A should also be extended a sufficient distance to permit of weight enough being attached to balance the arm. The credit for using the roller, which seems to be quite the best arrangement, is, we believe, due to John E. Sweet.

14. T. P. writes: I have a load of 10 000 pounds (5 tons) to be supported by an elliptic spring 30 inches long, like a locomotive or car-truck spring. I want the two parts (the upper and the lower part) to be 5 inches apart when the spring is loaded, the set due to the load to be 2½ inches. How can I find the length, breadth and thickness of the plates or leaves, and the number? *A.* We assume that each part of the spring is to be deflected 1¼ inch by the load. Make the length of the plates so that, beginning at the saddle, the spaces left uncovered on succeeding plates are equal. In other words the steps are equal, like the steps of stairs. Good dimensions for the plates would be $\frac{5}{16}$ x 3.5 inches. Assume that you use 11 leaves in each part of the spring. Each part of the spring must sustain a load of 2.5 tons. To find what it will be deflected by this load, divide the cube of the length of the spring multiplied by 1.5 by the width of the plate multiplied by the cube of its thickness in sixteenths of an inch and by the number of leaves. The quotient will be the deflection in sixteenths of an inch for each ton of load. Thus: $\frac{30^3 \times 1.5}{3.5 \times 5^3 \times 11} = 8.4$ sixteenths for each ton of load; $8.4 \times 2.5 = \frac{21}{16}$ or $1\frac{5}{16}$ inches, the total deflecting of each part of the spring. If fewer leaves are desired they may be made thicker, or if more deflection is desirable the leaves may be fewer. 2. If the truck wheel strikes an abrupt obstruction ¼ inch high, the speed being 35 miles per hour, how much more will the spring be deflected? *A.* That will depend upon the diameter of the wheel, which you neglect to give. However, anything in the way of a mathematical demonstration of this would involve useless labor. No result that could be depended upon would be obtained. If the wheel is from 24 to 30 inches diameter the deflection will not be greatly increased. 3. An eliptical spring has a length of 42 inches and the parts are 10½ inches apart when unloaded. The spring has six leaves in each part, five of them being 3½ x 3 inches and one 3½ x ½ inches. What load will deflect it 2½ inches? *A.* We assume that, as before, each part is to be deflected 1¼ inch. The mean thickness of the plates is 6.3 sixteenths. Then, as before, $\frac{42^3 \times 1.5}{3.5 \times 6.3^3 \times 6} = \frac{21}{16} +$; one ton will deflect each of the parts a little more than $1\frac{5}{16}$ inch.

15. J. T. N. asks: How many average men are supposed to be able to do work equal to that of a mechanical HP.? *A.* A mechanical HP. is the equivalent of raising 33 000 pounds one foot high in one minute of time, which is about what a horse will do. The effort of five men is about equivalent to that of one horse. Hence we may say that while they are working five men will do a mechanical HP. of work. If it comes to a question of endurance twenty men would equal one mechanical HP., because the men could scarcely do this work for more than six out of the twenty-four hours.

16. J. B. writes: I have, occasionally, small steel arbors 10 inches long to harden and grind. How can I harden them to prevent their springing so much? *A.* If you have, as we assume, only a few of these arbors to harden occasionally, you might screw a cap on a piece of 4-inch gas pipe that is a little longer than the arbors to be hardened. Arrange the pipe vertically so that the cap will come below the fire, the fire being against the outside of the pipe only. Fill the pipe with lead, melt it and bring it to the heat that a little practice shows to be the best. Immerse the arbors, vertically, in the lead until they are hot, then withdraw and immerse in water, holding them vertically until cool. The arbors will heat so quickly in the lead bath that when the outside is hot enough to harden the inside will be comparatively cool. They may be hardened in this way with but little springing.

Screw Machines Four Sizes.



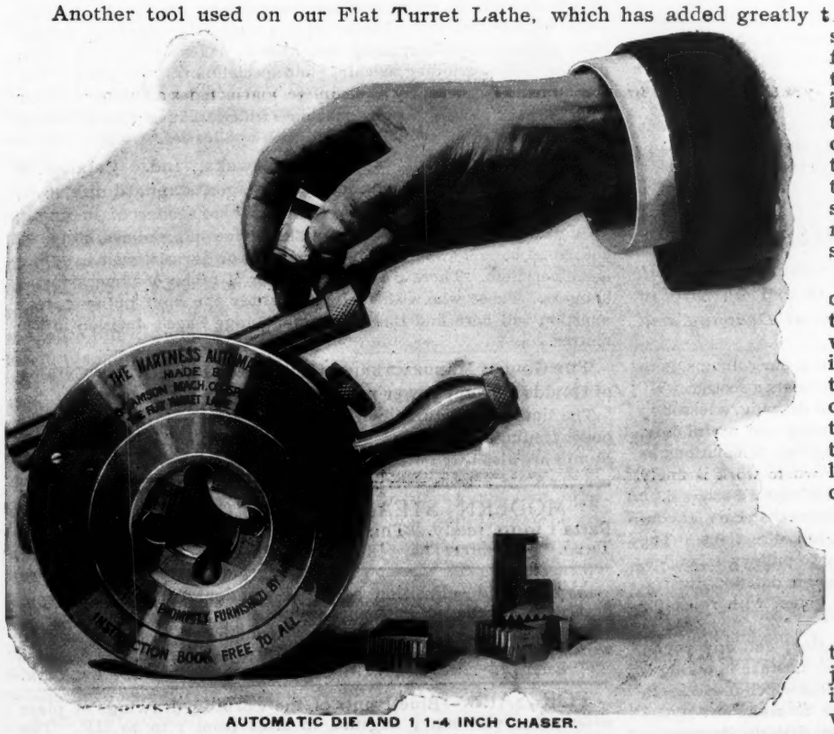
No. 5 Machine. Weight, 2,600 Pounds. Wire Feed Capacity, 1 3-4 inches.

THE PEARSON MACHINE CO., 31 W. Randolph St., Chicago, Ill.

See preceding issues of MACHINERY for detailed descriptions

A New Lathe System—IX.

Another tool used on our Flat Turret Lathe, which has added greatly to its efficiency, is the Automatic Die shown herewith. It cuts screw threads from 1¼ inches down to ¼ inch diameter, and as furnished with the machine in Outfit E or Automatic Die Outfit of tools, is provided with a complete set of chasers for cutting all right-hand threads of U. S. Standard from ⅜ inch to 1¼ inches diameter, inclusive, by sixteenths. It opens automatically by retarding the travel of its holder or shank.



AUTOMATIC DIE AND 1 1-4 INCH CHASER.

The process of milling the teeth on chasers is such that the front half of the chaser has a cutting clearance while the back half has none, but forms instead a lead nut, which rides in the thread produced by the front of the chaser. By this method an accurate thread is obtained, and we guarantee that our dies will cut a thread whose lead will come within a limit of accuracy of 1-64 inch per foot.

If you haven't investigated our lathe system how do you know we can't save you from 50 to 80 per cent. on the cost of your product? It costs nothing to find out, for our method of demonstrating the saving makes it possible to know just what the machine will accomplish in each shop, and entails no obligation whatever on the part of the enquirer.

THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VERMONT, U. S. A.

FOREIGN REPRESENTATIVES—HENRY KELLEY & Co., 26 Pall Mall, Manchester, England.
M. KOYEMANN, Charlottenstrasse, 112 Dusseldorf, Germany; representative for Germany, Belgium, Holland, Switzerland and Austria-Hungary.

MANUFACTURERS' NOTES.

THE DAVIS & EGAN MACHINE TOOL CO., of Cincinnati, have recently purchased the extensive plant of the Merril Chemical Co., which will be used as an addition to their present works and will be supplied with a complete lighting and power equipment. The same company also state that they have placed a large order through F. W. Horne, their representative in Japan and China, and another order at the Port Royal, S. C. navy yard.

WE did not suspect that the Meriden Machine Tool Company would go into the patent medicine business, but they have sent us a steel ring with the injunction that "Some people think a ring like the enclosed will cure rheumatism, if worn on the finger." We do not know whether it will or not, but we know it was turned on our new 15-inch special "Gas Fixture Manufacturer's forming lathe by simply pulling a handle." The ring looks well enough to get married with, and we would suggest that if anyone is thinking of taking this step he would not make any mistake in specifying that the ring be made in one of these machines.

THE PRATT & WHITNEY CO. have removed their Boston office to 144 Pearl street, corner of Purchase, where they will have largely increased facilities for serving their patrons. They will carry in stock a large assortment of machinists' tools, together with small tools, viz., taps, dies, reamers, milling cutters, etc. Alfred L. Lovejoy, who represents the Pratt & Whitney Co., also represents the T. & B. Tool Co. and will carry a stock of constant angle twist drills.

THE Hoppes Manufacturing Company, of Springfield, O., report an improvement in business within the past few weeks, having received orders from the Union Traction Co., Philadelphia, Henry R. Worthington, Westinghouse, Church, Kerr & Co. and other well known firms. These orders have amounted to 12 feed water heaters, aggregating 10,000 HP., and 3 feed water purifiers, aggregating 1,000 HP.

THE Armstrong Manufacturing Company of Bridgeport, Conn., and 139 Centre street, New York, have recently made a number of improvements in their No. "0" Pipe Machine, for ¼ inch to 2 inch pipe. They are also making this machine to run by power as well as by hand to suit the work of large shops and mills, and report that the demand for it has been very great the last few months.

AMONG the many business firms that report an increase in business is the Penberthy Injector Co., of Detroit, Mich. The banner year for this firm was 1895, but their sales up to September 1st of the present year have been in advance of those of any previous year. This firm has lately placed on the market an auto-positive injector of remarkable range, being built with only five working parts and doing the work of the most complicated injectors, having from 30 to 60 pieces in their make-up. It seems almost incredible that an injector with three jets and two valves could accomplish a range of from 15 to 250 lbs. steam pressure, but this is the range which is claimed for this machine.

THE LODGE & SHIPLEY MACHINE TOOL CO., which is a comparatively new concern, having been organized in 1892, report that their business has shown a substantial growth from month to month until they now own and use a building with three floors, 96 x 71 feet. Their export business has been good and during the past few months there has been a marked improvement in their domestic trade. This company devotes its entire attention to the manufacture of lathes.

* * *

FRESH FROM THE PRESS.

We have received from the Arnold Publishing House, 16 Thomas St., New York City, the 3rd, 4th, 5th and 6th parts of J. G. A. Meyers' ***Easy Lessons in Mechanical Drawing and Machine Design.***

This series, which has received previous notice in our columns, is to be issued in 24 parts of about 32 pages each, at 50 cents a section.

Every section contains a lesson in geometrical drawing, a lesson in machine design and a collection of practical rules and useful data, explaining, in a clear way, such simple arithmetical calculations as come up in the course of the lessons. The whole work is finely executed, and has a great many illustrations, which are all original.

As an example of what is given, it may be stated that Part III contains twenty-five geometrical problems with full directions. The principle of proportion, with examples applying to pulleys, triangles, etc., is fully explained, and for the machine design, detailed illustrations of certain parts of an engine lathe are given, with rules for calculating change gears.

The whole work is intended for self-instruction, and any young mechanic, who wishes to advance, would make no mistake in taking it up and following through the course of instruction which it gives. In fact, we think that, if a young apprentice were to study Mr. Myers' work regularly and faithfully during his apprenticeship, devoting a few hours a week to it, his chances for advancement when he became a journeyman would be greatly improved.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

THE WOODWORKERS' CATALOGUE. C. A. Strelinger Co., Detroit, Mich. 400 pages (same size as *Book of Tools*), flexible binding, thin paper, round corners, 25 cents; heavy covers and paper $1.00.

Strelinger's *Book of Tools* was a radical departure from the stereotyped dealers' catalogue, and that it met a want was shown by the sale of nearly 50,000 copies, which have brought to the publishers orders from nearly every country in the world. It is difficult to believe that a machinery dealer in such a comparatively remote place as Detroit can sell goods through a catalogue in Spain, China and Egypt, not to mention countries near by; but the evidences of these sales are shown in the Detroit store in the form of letters from nearly all parts of the globe. The *Woodworkers' Catalogue* is the twin brother and continuation of the *Book of Tools*, printed and bound in the same style and having the same size pages, which are numbered from 600 to 1,000, doubtless for the convenience of those who have the preceding volume, most of whom will probably buy this also. The only fault we have to find in the book is with the engravings, a number of which are not up to the catalogue standard; and with due consideration for the cost involved we think it would have paid to use better ones. Many a poor tool has been sold by a good engraving, and many a good tool has missed selling because of a poor engraving. We observe that Mr. Strelinger has not given the names and addresses of the various manufacturers in this catalogue.

WEBER GAS AND GASOLINE ENGINE CO., Kansas City, Mo. Catalog of gas engines designed for hoisting.

The fact that gas engines are applied regularly to hoisting will be quite new to many. The Weber Company build self-contained hoisting plants, for mining and other purposes, consisting of engine and drums, complete. Size of catalog 6 x 9½ inches. The cuts are not large and it would have been as easy to have made it 6 x 9 inches.

ISRAEL H. JOHNSON, JR., & CO., Philadelphia, Pa. Illustrated catalog of lathes and other machine tools.

The regular line of engine lathes illustrated range in size from 13 inches to 68 inches swing. Turret and other special forms of lathes are included, besides various attachments and foot-power lathes. Some power shears and punches are also included. Size of catalog, standard, 9 x 12 inches.

THE NEWBURGH ICE MACHINE & ENGINE CO., Newburgh, N.Y., have issued a small pamphlet describing their Corliss Engines and ice-making machines. The latter are made in sizes suited to family use, as well as in large sizes for refrigerating plants.

THE GARVIN MACHINE CO., Spring and Varick streets, New York, have issued list No. 20, of new and second-hand machinery, in stock for immediate delivery. The list of new machinery comprises, besides their own manufacture, many well-known makes of machine tools, presses, shears, grinding machines and special bicycle machines. The second-hand list is nearly as complete, and includes a number of their well-known milling and screw machines which are in as good condition as when new. The list will be sent upon application.

DODGE MANUFACTURING CO., Mishawaka, Ind. Catalog of power transmission appliances; 288 pages, standard size, 6 x 9 inches.

Contains descriptions and lists of the Dodge split pulleys, clutches, couplings, hangers, shafting, rope transmission devices, grain handling machinery, etc. There are also a number of tables of dimensions of hangers. Those who wish to further study the split pulley patent question will here find the full text of Judge Sage's decision in the matter.

THE GOULDS MANUFACTURING CO., Seneca Falls, N. Y. Catalog of Goulds efficient power pumps; 80 pages, 7 x 8 inches.

The line manufactured by this company includes triplex pumps for boiler feeding, tank, mine, suction, rotary and ammonia pumps, etc. Pumps are also listed with electric and gas engine drive.

"MODERN STEAM ENGINE CONSTRUCTION." Parts 1 to 10, ready. Thirty cents each. tf
THEO. F. SCHEFFLER, JR., 943 East 21st Street, Erie, Pa.

WANTED—Position as superintendent or foreman, by a first-class mechanic and successful shop manager. Age, 49 years; 30 years shop experience. Accustomed to steam engine work, pumping machinery and general machine work. Address "Energy," care of MACHINERY, 411-413 Pearl St., New York.

FOR SALE.—Blue Prints of the working drawings of plain slide valve stationary engines, in sizes from 1 to 40 HP. The latest and best, at a reasonable price. Let me send table of screw threads and decimal equivalents—it's handy.
OTTO E. EVANS, York, Neb.